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DOMESTIC RETROSPECT AND PROSPECT.[1]

By HERBERT SPENCER.

INDUCTION has greatly predominated over deduction throughout the foregoing chapters; and readers who have borne in mind that Part II. closes with a proposal to interpret social phenomena deductively, may infer either that this intention has been lost sight of, or that it has proved impracticable to deal with the facts of domestic life otherwise than by empirical generalization. On gathering together the threads of the argument, however, we shall find that the chief conclusions forced on us by the evidence are those which Evolution implies.

We have first the fact that, little as it might have been expected, the genesis of the family fulfills the law of Evolution under its leading aspects. In the rudest social groups nothing to be called marriage exists: the unions of the sexes are extremely incoherent. Family groups, consisting of mothers and such few children as can be reared without permanent paternal assistance, are necessarily small and soon dissolve: integration is slight. Within each group the relationships are less definite; since the children are mostly half-brothers or half-sisters, and the paternity is often uncertain. From such primitive families, thus small, incoherent, and indefinite, there arise, in conformity with the law of Evolution, divergent and redivergent types of families—some characterized by a mixed polyandry and polygyny; some that are polyandrous, differentiating into the fraternal and non-fraternal; some that are polygynous, differentiating into those composed of wives and those composed of a legitimate wife and concubines; some that are monogamous, among which, besides the ordinary form, there is the aberrant form distinguished by a wife

[1] Conclusion to the chapters on "The Domestic Relations," which complete vol. i. of the "Principles of Sociology."

married only for a part of each week. Of these genera and species of families, those varieties which are found in advanced societies are the most coherent, most definite, most complex. Not to dwell on intermediate types, we see, on contrasting with the primitive kind of family group that highest kind of family group which civilized peoples present, how relatively high is its degree of evolution. The marital relation has become perfectly definite; it has become extremely coherent—commonly lasting for life; in its initial form of parents and children it has grown larger—the number of children reared by savages being comparatively small; in its derived form, comprehending grandchildren, great-grandchildren, etc., all so connected as to form a definable cluster, it has grown relatively large; and this large cluster consists of members whose relationships are very heterogeneous.

Again, the developing human family fulfils, in increasing degrees, those traits which we saw at the outset are traits of the successively-higher forms of reproductive arrangements throughout the animal kingdom. Maintenance of species being the end to which maintenance of individual lives is necessarily subordinated, we find, as we ascend in the scale of being, a diminishing sacrifice of individual lives in the achievement of this end; and, as we ascend through the successive grades of societies with their successive grades of family, we find a further progress in the same direction. Human races of the lower types, as compared with those of the higher, show us a greater sacrifice of the adult individual to the species; alike in the brevity of that stage which precedes reproduction, in the relatively heavy tax entailed by the rearing of children under the conditions of savage life, and in the abridgment of the period that follows: women especially, early bearing children and exhausted by the toils of maternity, having a premature old age soon cut short. In superior family types there is also less sacrifice of juvenile life: infanticide, which in the poverty-stricken groups of primitive men is dictated by the necessities of social self-preservation, becomes rarer; and juvenile mortality otherwise caused decreases at the same time. Further, along with the diminishing sacrifice of adult life, there goes an increasing compensation for the sacrifice that has to be made: more prolonged and higher pleasures are taken in rearing progeny. Instead of states in which children are early left to provide for themselves, or in which, as among Bushmen, fathers and sons quarreling try to kill one another, or in which, as Burton says of the East Africans, "when childhood is past, the father and son become natural enemies, after the manner of wild beasts," there comes a state in which keen interest in the welfare of children extends throughout parental life. And then to this pleasurable care of offspring, increasing in duration as the family develops, has to be added an entirely new factor—the reciprocal pleasurable care of parents by offspring: a factor which,

feeble where the family is rudimentary and gaining strength as the family develops, serves in another way to lessen the sacrifice of the individual to the maintenance of the species, and begins, contrariwise, to make the maintenance of the species conduce to the more prolonged life, as well as to the higher life, of the individual.

A fact not yet named remains. Evolution of the higher types of family, like evolution of the higher types of society, has gone hand-in-hand with evolution of human intelligence and feeling. The general truth that there exists a necessary connection between the nature of the social unit and the nature of the social aggregate, and that each continually moulds and is moulded by the other, is a truth which holds of domestic organization as well as of political organization. The ideas and sentiments which make possible any more advanced phase of associated life, whether in the family or in the state, imply a preceding phase by the experiences and discipline of which they were acquired; and these, again, a next preceding phase; and so from the beginning. On turning to the last part of the "Principles of Psychology" (edition of 1872), containing chapters on "Development of Conceptions," "Sociality and Sympathy," "Ego-Altruistic Sentiments," "Altruistic Sentiments," the reader will find it shown how the higher forms alike of intellect and feeling, made possible only by the social environment, evolve as this environment evolves—each increment of advance in the one being followed by an increment of advance in the other. And carrying out this doctrine he will see that since altruism plays an important part in developed family life, the higher domestic relations have become possible only as the adaptation of man to the social state has progressed.[1]

In considering deductively the connections between the forms of domestic life and the forms of social life, and in showing how these are in each type of society related to one another because jointly related to the same type of individual character, it will be convenient to deal simultaneously with the marital arrangement, the family structure, the *status* of women, and the *status* of children.

Primitive life, cultivating antagonism to prey and enemies, brute or human—daily yielding the egoistic satisfaction of conquest over alien beings which prove to be weaker, daily gaining pleasure from acts which entail pain—maintains a type of nature which generates coercive rule, social and domestic. Brute strength glorying in the predominance which brings honor, and unchecked by regard for others' welfare, seizes whatever women fancy prompts, adding to them and changing them at will. And children, at the mercy of this utter self-

[1] As included in the general theory of the adaptation of organic beings to their circumstances, this doctrine that the human mind, especially in its moral traits, is moulded by the social state, pervades *social statics;* and is especially insisted upon in the chapter entitled "General Considerations."

ishness, are preserved only when and as far as the instinct of parenthood predominates. Clearly, then, weakness of the marital relation, indefinite incoherent forms of family, harsh treatment of women, and infanticide, are inevitable concomitants of militancy in its extreme form.

The advance from these lowest social groups, hardly to be called societies, to groups that are larger, or have more structure, or both, implies increased coöperation. This coöperation may be compulsory or voluntary, or it may be, and usually is, partly the one and partly the other. We have seen that great militancy implies predominance of compulsory coöperation, and that great industrialness implies predominance of voluntary coöperation. Here we have to observe that it is deductively manifest, as we have found it inductively true, that the accompanying domestic relations are in each case congruous with the necessitated social relations.

The individual nature which exercises that despotic control and submits to that extreme subjection implied by pronounced militancy in developing societies, no less than the fostering of egoism and repression of sympathy by a life devoted to war, inevitably determines the arrangements within the household as it does the arrangements without it. Hence the disregard of women's claims shown in stealing and buying them; hence the inequality of *status* between the sexes entailed by polygyny; hence the use of women as laboring slaves; hence the life and death power over wife and child; and hence that constitution of the family which subjects all its members to the eldest male.

Conversely, the type of individual nature developed by voluntary coöperation in societies that are predominantly industrial, whether they be peaceful, simple tribes, or nations that have in great measure outgrown militancy, is a relatively-altruistic nature. The daily habit of exchanging services, or giving products representing work done for money representing work done, is a habit of seeking such egoistic satisfaction as allows like egoistic satisfactions to those dealt with. There is an enforced respect for others' claims; there is an accompanying mental representation of their claims implying, in so far, fellow-feeling; and there is an absence of those repressions of fellow-feeling involved by coercion. Necessarily, the type of character thus cultivated, while it modifies social actions and arrangements, modifies also domestic actions and arrangements. The discipline which brings greater recognition of the claims of fellow-men brings greater recognition of the claims of women and children. The practice of consulting the wills of those with whom there is coöperation outside the household, brings with it the practice of consulting the wills of those with whom there is coöperation inside the household. The marital relation becomes changed from one of master and subject into one of approximately-equal partnership; while the bond becomes

less that of legal authority and more that of affection. The parental and filial relation ceases to be a tyranny which sacrifices child to parent, and becomes one in which, rather, the will of the parent subordinates itself to the welfare of the child.

Thus the results deducible from the natures of militancy and industrialness correspond with those which we have found are, as a matter of fact, exhibited. And, as implying the directness of the alleged connections, I may here add an instance showing that in the same society the domestic relations in the militant part retain the militant character, while the domestic relations in the industrial part are beginning to assume the industrial character. Commenting on the laws of inheritance in ancient France, as affecting children of different sexes and different ages, Königswarter remarks that "it is always the feudal and noble families which cling to the principle of inequality, while the ideas of equality penetrate everywhere into the *roturières* and *bourgeoises* families." Similarly Thierry, speaking of a new law of the thirteenth century, equalizing rights of property between the sexes and among children, says: "This law of the *bourgeoisie*, opposed to that of the nobles, was distinguished from it by its very essence. It had for its basis natural equity."

And now we come to the interesting question, "What may be inferred respecting the future of the domestic relations?" We have seen how the law of evolution in general has been thus far fulfilled in the genesis of the family. We have also seen how, during civilization, there has been carried still further that conciliation of the interests of the species, of the parents, and of the offspring, which has been going on throughout organic evolution at large. Further, we have noted that these higher traits in the relations of the sexes to one another and to children, which have accompanied social evolution, have been made possible by those higher traits of intelligence and feeling produced by the experiences and disciplines of progressing social states. And we have, lastly, observed the connections between special traits so acquired and special types of social structure and activity. Assuming, then, that evolution will continue along the same lines, let us consider what further changes may be anticipated.

It is first inferable that, throughout times to come, the domestic relations of different peoples inhabiting different parts of the earth will continue to be unlike. We must beware of supposing that developed societies will become universal. As with organic evolution, so with super-organic evolution, the production of higher forms does not involve extinction of all lower forms. As superior species of animals, while displacing certain inferior species that compete with them, leave many other inferior species in possession of inferior habitats, so the superior types of societies, while displacing those inferior types occupying localities they can utilize, will not displace inferior

types inhabiting barren or inclement localities. Civilized peoples are unlikely to expel the Esquimaux. The Fuegians will probably survive, because their island cannot support a civilized population. It is questionable whether the groups of wandering Semites who have for these thousands of years occupied Eastern deserts will be extruded by societies of higher kinds. And perhaps many steaming malarious regions in the tropics will remain unavailable by races capable of much culture. Hence the domestic, as well as the social, relations proper to the lower varieties of man are not likely to become extinct. Polyandry may survive in Thibet; polygyny may prevail throughout the future in parts of Africa; and, among the remotest groups of hyperboreans, mixed and irregular relations of the sexes will probably continue.

It is possible, too, that in certain regions militancy may persist, and that along with the political relations natural to it there may survive the domestic relations natural to it. Wide tracts, such as those of Northeastern Asia, unable to support populations dense enough to form industrial societies of advanced types, will perhaps remain the habitats of societies having those imperfect forms of state and family which go along with offensive and defensive activities.

Omitting such surviving inferior types, we may here limit ourselves to types carrying further the evolution which civilized nations now show us. Assuming that among these industrialism will increase and militancy decrease, we have to ask what are the domestic relations likely to coexist with complete industrialism.

The monogamic form of the sexual relation is manifestly the ultimate form; and any changes to be anticipated must be in the direction of completion and extension of it. By observing what possibilities there are of greater divergence from the arrangements and habits of the past, we shall see what modifications are probable.

Many acts that are normal with the uncivilized are, with the civilized, transgressions and crimes. Promiscuity, once unchecked, has been more and more reprobated as societies have progressed; abduction of women, originally honorable, is now criminal; the marrying of two or more wives, allowable and creditable in inferior societies, has become in superior societies felonious. Hence, future evolution, along lines thus far followed, may be expected to extend the monogamic relation by extinguishing promiscuity, and by suppressing such crimes as bigamy and adultery. Dying out of the mercantile element in marriage may also be inferred. After wife-stealing came wife-purchase; and then followed the usages which made, and continue to make, considerations of property predominate over considerations of personal preference. Clearly, wife-purchase and husband-purchase (which exists in some semi-civilized societies), though they have lost their original gross forms, persist in disguised forms. Already some

disapproval of those who marry for money or position is expressed; and this, growing stronger, may be expected to purify the monogamic union by making it in all cases real instead of being in some cases nominal.

As monogamy is likely to be raised in character by a ublic sentiment requiring that the legal bond shall not be entered into unless it represents the natural bond, so, perhaps, it may be that maintenance of the legal bond will come to be held improper if the natural bond ceases. Already increased facilities for obtaining divorce point to the probability that, whereas, in those early stages during which permanent monogamy was being evolved, the union by law (originally the act of purchase) was regarded as the essential part of marriage, and the union by affection as non-essential, and whereas at present the union by law is thought the more important and the union by affection the less important, there will come a time when the union by affection will be held of primary moment and the union by law as of secondary moment: whence reprobation of marital relations in which the union by affection has dissolved. That this conclusion will seem unacceptable to most is probable—I may say, certain. In passing judgment on any modified arrangement suggested as likely to arise hereafter, nearly all err by considering what would be likely to result from the supposed change, all other things remaining unchanged. But other things must be assumed to have changed *pari passu*. Those higher sentiments accompanying union of the sexes, which do not exist among primitive men, and were less developed in early European times than now (as is shown in the contrast between ancient and modern literatures), may be expected to develop still more as decline of militancy and increase of industrialness foster altruism; for sympathy, which is the root of altruism, is a chief element in these sentiments. Moreover, with an increase of altruism must go a decrease of domestic dissension. Whence, simultaneously, a strengthening of the moral bond and a weakening of the forces tending to destroy it. So that the changes which may further facilitate divorce under certain conditions are changes which will make those conditions more and more rare.

There may, too, be anticipated a strengthening of that ancillary bond constituted by joint interest in children. In all societies this is an important factor, and has sometimes great effect among even rude peoples. Falkner remarks that although the Patagonian marriages "are at will, yet when once the parties are agreed, and have children, they seldom forsake each other, even in extreme old age." And this factor must become more efficient in proportion as the solicitude for children becomes greater and more prolonged, as we have seen that it does with progressing civilization, and must continue to do.

But leaving open the question what modifications of monogamy, conducing to increase of real cohesion rather than nominal cohesion,

are likely to arise, there is one conclusion we may draw with certainty. Recurring to the three ends to be subserved in the order of their importance—welfare of species, welfare of offspring, welfare of parents—and seeing that, in the stages now reached by civilized peoples, welfare of species is effectually secured in so far as maintenance of numbers is concerned, the implication is that welfare of offspring must hereafter determine the course of domestic evolution. Societies which from generation to generation produce in due abundance individuals who, relatively to the requirements, are the best physically, morally, and intellectually, must become the predominant societies, and must tend through the quiet process of industrial competition to replace other societies. Consequently, marital relations which favor this result in the greatest degree must spread, while the prevailing sentiments and ideas must become so moulded into harmony with them that other relations will be condemned as immoral.

If, still guiding ourselves by observing the course of past evolution, we ask what changes in the *status* of women may be anticipated, the answer must be that a further approach toward equality of position between the sexes will take place. With decline of militancy and rise of industrialness—with decrease of compulsory coöperation and increase of voluntary coöperation—with strengthening sense of personal rights and accompanying sympathetic regard for the personal rights of others, must go a diminution of the political and domestic disabilities of women, until there remain such only as differences of constitution entail.

To draw inferences more specific is somewhat hazardous: probabilities and possibilities only can be indicated. While in some directions the emancipation of women has to be carried further, we may suspect that in other directions their claims have already been pushed beyond the normal limits. If from that stage of primitive degradation in which they were habitually stolen, bought and sold, made beasts of burden, inherited as property, and killed at will, we pass to the stage America shows us, in which a lady wanting a seat stares at a gentleman occupying one until he surrenders it, and then takes it without thanking him, we may infer that the rhythm traceable throughout all changes has carried this to an extreme from which there will be a recoil. The like may be said of some other cases: what were originally concessions have come to be claimed as rights, and, in gaining the character of assumed rights, have lost much of the grace they had as concessions. Doubtless, however, there will remain in the social relations of men and women, not only observances of a kind called forth by sympathy of the strong for the weak irrespective of sex, and still more called forth by sympathy of the stronger sex for the weaker sex, but also observances which originate in the wish, not consciously formulated but felt, to compensate women for certain

disadvantages entailed by their constitutions, and so to equalize the lives of the sexes as far as possible.

In respect of domestic power, the relative position of women will doubtless rise; but it seems improbable that absolute equality with men will be reached. Legal decisions from time to time demanded by marital differences, involving the question which shall yield, are not likely to reverse all past decisions. Evenly though law may balance claims, it will, as the least evil, continue to give, in case of need, supremacy to the husband, as being the more judicially-minded. And, similarly, in the moral relations of married life, the preponderance of power, resulting from greater massiveness of nature, must, however unobtrusive it may become, continue with the man.

When we remember that up from the lowest savagery civilization has, among other results, brought about an increasing exemption of women from bread-winning labor, and that in the highest societies they have become most restricted to domestic duties and the rearing of children, we may be struck by the anomaly that at the present time restriction to indoor occupations has come to be regarded as a grievance, and a claim is made to free competition with men in all out-door occupations. This anomaly is traceable in part to the abnormal excess of women; and obviously a state of things which excludes many women from those natural careers in which they are dependent on men for subsistence justifies the demand for freedom to pursue independent careers. That any hinderances standing in their way should be, and will be, abolished must be admitted. At the same time it must be contended that no considerable alteration in the careers of women in general can be, or should be, so produced; and, further, that any extensive change in the education of women, made with the view of fitting them for businesses and professions, would be mischievous. If women comprehended all that is contained in the domestic sphere, they would ask no other. If they could see all that is implied in the right education of children, to a full conception of which no man has yet risen, much less any woman, they would seek no higher function.

That in time to come the political *status* of women may also be raised to something like equality with that of men, seems a deduction naturally accompanying the preceding ones. But such an approximate equalization, normally accompanying a social structure of the completely industrial type, is not a normal accompaniment of social types still partially militant. Just noting that the giving to men and women equal amounts of political power, while the political responsibilities entailed by war fell upon men only, would involve a serious inequality, and that the desired equality is therefore impracticable while wars continue, it may be contended that though the possession of political power by women would possibly improve a society in which state-regulation had been brought within the limits proper to

pure industrialism, it would injure a society in which state-regulation has the wider range characterizing a more or less militant type. Several influences would conduce to retrogression. The greater respect for authority and weaker sentiment of individual freedom characterizing the feminine nature would tend toward the maintenance and multiplication of restraints. Ability to appreciate special and immediate results, joined with inability to appreciate general and remote results, characterizing the majority of men, and still more characterizing women, would, if women had power, entail increase of coercive measures for achieving present good, at the cost of future evil caused by excess of control. But there is a more direct reason for anticipating mischief from the exercise of political power by women, while the industrial form of political regulation is incomplete. We have seen that the welfare of a society requires that the ethics of the family and the ethics of the state shall be kept distinct. Under the one the greatest benefits must be given where the merits are the smallest; under the other the benefits must be proportioned to the merits: for the infant, unqualified generosity; for the adult citizen, absolute justice. The ethics of the family have for their correlatives the parental instincts and sentiments, which, in the female, are qualified in a smaller degree by other feelings than in the male. Already these emotions proper to parenthood, as they exist in men, lead them to carry the ethics of the family into the policy of the state; and the mischief resulting would be increased were these emotions, as existing in women, directly to influence that policy. The progress toward justice in social arrangements would be retarded, and demerit would be fostered at the expense of merit still more than now.

But, in proportion as the conceptions of pure equity become clearer; as fast as the *régime* of voluntary coöperation develops to the full the sentiment of personal freedom, with a correlative regard for the like freedom of others; as fast as there is approached a state under which no restrictions upon individual liberty will be tolerated, save those which the equal liberties of fellow-citizens entail; as fast as industrialism evolves its appropriate political agency, which, while commissioned to maintain equitable relations among citizens, is shorn of all those powers of further regulation proper to the militant type; so fast may the extension of political power to women go on without evil. The moral evolution which leads to concession of it will be the same moral evolution which renders it harmless and probably beneficial.

No very specific conclusions are to be drawn respecting future changes in the *status* of children. Parental and filial relations, less regulated in detail by law and custom than all others, have more readily changed under the influence of changed sentiments and ideas, and, while becoming generally liberalized, have become so far varied that it is difficult to characterize them.

While an average increase of juvenile freedom is to be anticipated, there is reason to think that here and there it has already gone too far. I refer to the United States. Besides in some cases unduly subordinating the lives of adults, the degree of independence there allowed to the young appears to have the effect of bringing them forward prematurely, initiating them too early in the excitements proper to maturity, and so tending to exhaust the interests of life before it is half spent. Such regulation of childhood as conduces to full utilization of childish activities and pleasures, before the activities and pleasures of manhood and womanhood are entered upon, is better for offspring at the same time that it is better for parents.

How far is parental authority to go? and at what point shall political authority check it? are questions to be answered in no satisfactory way. Already I have given reasons for thinking that the powers and functions of parents have been too far assumed by the state; and that probably a reintegration of the family will follow its present undue disintegration. It seems possible that from the early form in which social and family organizations are compulsory in character, we are passing through semi-militant, semi-industrial phases, in which the organizations of both state and family are partly compulsory, partly voluntary, in character; and that, along with complete social reintegration on the basis of voluntary coöperation, will come domestic reintegration of allied kind, under which the life of the family will again become as distinct from the life of the state as it originally was. Still there remain the theoretical difficulties of deciding how far the powers of parents over children may be carried; to what extent disregard of parental responsibilities is to be tolerated; when does the child cease to be a unit of the family and become a unit of the state. Practically, however, these questions will need no solving; since the same changes of character which bring about the highest form of family will almost universally prevent the rise of difficulties which result from characters of lower types proper to lower societies.

Moreover, there always remains a security. Whatever conduces to the highest welfare of offspring must more and more establish itself through the replacing of children of inferior parents reared in inferior ways by children of better parents reared in better ways. As lower creatures at large have been preserved and advanced through the instrumentality of parental instincts; and as in the course of human evolution the domestic relations originating from the need for prolonged care of offspring have been assuming higher forms; and as the care taken of offspring has been becoming greater and more enduring; we need not doubt that, in the future, along with the more altruistic nature accompanying a higher social type, there will come relations of parents and children needing no external control to insure their well-working.

One further possibility of domestic evolution remains. The last component to show itself among the feelings which hold the family together, the care of parents by offspring, is the one which has most room for increase. Absent in brutes, small among primitive men, considerable among the partially civilized, and tolerably strong among the best of those around us, filial affection is a feeling that admits of much further growth, which is needed to make the cycle of domestic life complete. At present, the latter days of the old whose married children live away from them are made dreary by the lack of those remaining pleasures to be derived from the constant society of descendants; but the time will come when this evil will be met by an attachment of adults to parents which, if not as strong as that of aged parents to children, approaches it in strength.

Further development in this direction will not, however, occur under social arrangements which partially absolve parents from the care of offspring. A stronger feeling to be displayed by child for parent in later life must be established by a closer intimacy between parent and child in early life. No such higher stage is to be reached by walking in the ways followed by the Chinese for these two thousand years. We shall not rise to it by imitating, even partially, the sanguinary Mexicans, whose children, at the age of four, or sometimes later, were delivered over to be educated by the priests. We shall not improve family feeling by approaching toward the arrangements of the Koossa-Caffres, among whom "all children above ten or eleven years old are publicly instructed under the inspection of the chief." This latest of the domestic affections will not be fostered by retrograding toward customs like those of the Andamanese, and, as early as possible, changing the child of the family into the child of the tribe. Contrariwise, such a progress will be achieved only in proportion as both moral and intellectual culture are carried on by parents to an extent now rarely attempted. When the unfolding minds of children are no longer thwarted, and stunted, and deformed, by the mechanical lessons of stupid teachers—when instruction, instead of giving mutual pain, gives mutual pleasure by ministering in proper order to faculties which are severally eager to appropriate fit knowledge presented in fit forms—when, with a wide diffusion of adult culture, joined with rational ideas of teaching, there goes a spontaneous unfolding of the juvenile mind such as is even now occasionally indicated by exceptional facility of acquisition—when the earlier stages of education passed through in the domestic circle have become, as they will in ways scarcely dreamed of at present, daily aids to the strengthening of sympathy, intellectual and moral, leaving only the more special cultures to be carried on by others; then will the latter days of life be smoothed by a greater filial care, reciprocating the greater parental care bestowed in earlier life.

ODD FORMS AMONG FISHES.

By Professor SANBORN TENNEY.

PROBABLY there is no group of animals—certainly no group of vertebrates—that exhibits more strange and even monstrous forms than fishes.

The typical fish, we may well believe, is some such form as the salmon, or the cod, or the bass, or an average of these and their numerous allies. In a word, the ordinary fishes of the ocean, lakes, and streams, give us essentially the true idea of the typical fish.

But what remarkable departures from these ordinary forms do we

Fig. 1.—Salmon, introduced here as an example of a typical fish.

find when we take a survey of the whole vast group of animals that are called fishes!

Let us take the salmon as a fair sample of an ordinary fish, and then briefly notice a few of the strange forms to which the name is applied.

If we look at the rays (Fig. 2), we see "fishes" whose width is so great in proportion to their length, that in giving their dimensions it would seem to be quite the natural thing to put down the *width* as the prominent measurement instead of the length, as is our custom in the case of ordinary fishes. And it may be remarked here that the great relative breadth of these animals is connected with the kind of movements which they exhibit in progression. Instead of ordinary swimming, these animals effect locomotion by a sort of flight through the waters; and hence are often called "sea-eagles," "sea-vampires," etc. They all belong to the sea. Some of the rays are of wonderful dimensions, although the ordinary kinds are only about two or three feet wide. One was taken near Messina which weighed half a ton. One taken near Barbadoes is said to have been so large that it required seven yoke of oxen to draw it! Levaillant tells us of one which was thirty feet wide and twenty-five feet long; and Dekay states that one of these monsters of the deep has been known to seize the cable of a small vessel at anchor, and draw it several miles with great velocity!

The rays have the mouth, nostrils, and gill-openings, on the under-side. Like the sharks, they are without gill-covers, and have the gills fixed by both margins. Their teeth differ from those of all ordinary

FIG. 2.—STING-RAY (*Trygon hastata*, Storer).

fishes, being of a definite form, bounded by planes symmetrically arranged, the whole forming a beautiful mosaic (Fig. 3).

Remarkable as are the form and general structure of the rays, as indicated above, a still more remarkable structure is exhibited in some

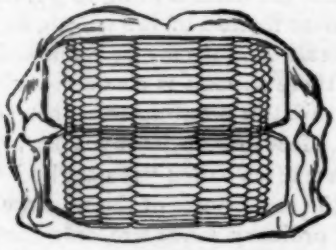

FIG. 3.—TEETH OF A RAY.

of them; for those known as torpedoes (Fig. 4) are so constructed that they are a powerful galvanic battery. These have the space between the pectoral fins, the head, and the gills, on each side, filled with membranous tubes which are divided by horizontal partitions into small cells filled with a sort of mucus and traversed by nerves;

and by means of this apparatus they give violent shocks to animals with which they come in contact.

Hardly less strange than the rays are those animal structures

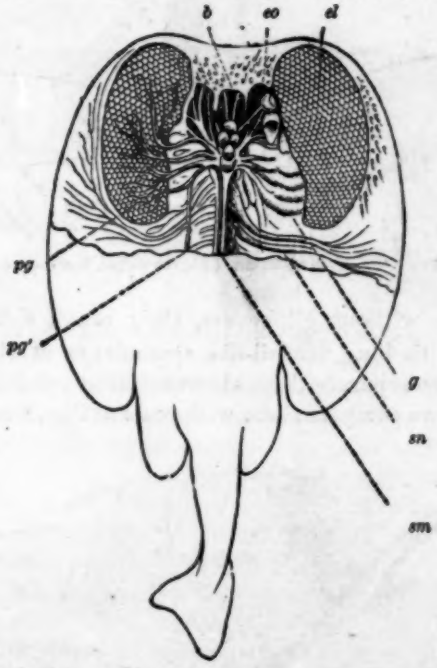

Fig. 4.—Torpedo. *b*, brain; *eo*, eye and optic nerve; *el*, electric organs; *sn*, spinal nerves; *sm*, spinal marrow; *pg*, pneumogastric nerves going to the electric organs; *pg'*, branch of the preceding; *g*, gills.

which remind us somewhat of the rays on the one hand, and the sharks on the other, but which differ from both in several important respects, but especially in having a very long depressed and bony

Fig. 5.—Mackerel-Shark (*Lamna punctata*, Storer).

snout, armed on each side with spines implanted like teeth, the whole constituting a most formidable weapon. These are the sawfishes (Fig. 7), which attain a length of fifteen feet or more.

Every one sees at a glance that the sharks (Figs. 5, 6, 7) are widely different from all ordinary fishes. Their peculiar outline in general, their unequal-lobed tail, their transverse mouth on the underside of the head, their formidable array of lancet-shaped teeth,

FIG. 6.—THRESHER-SHARK (*Alopias vulpes*, Bonaparte).

their fixed gills without gill-covers, their rough skin, their pillow-shaped eggs with long, tendril-like appendages at the corners (Fig. 8), all combine to separate them about as far as possible from typical fishes. And if we compare them with one another, what wonderfully-

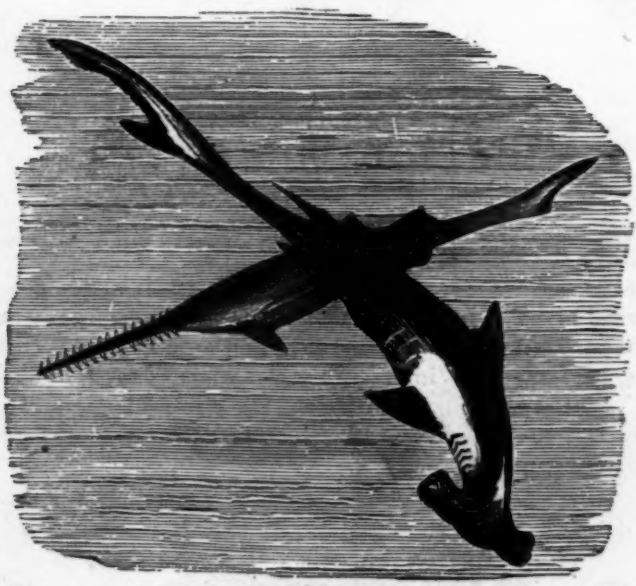

FIG. 7.—HAMMER-HEAD SHARK (*Zygæna malleus*, Valenciennes); and SAWFISH (*Pristis antiquorum*, Latham).

diversified forms do we see as we pass from the dog-sharks to the mackerel-sharks, and from the latter to the white sharks, and from these to the threshers, and to the hammer-heads, and so on through the whole list!

And who that has studied only the ordinary fishes would at length

expect to find such a fish as the chimæra (Fig. 9)—an animal whose general appearance, it is true, is somewhat shark-like, but which, if possible, is more strange and monstrous than any of the sharks or

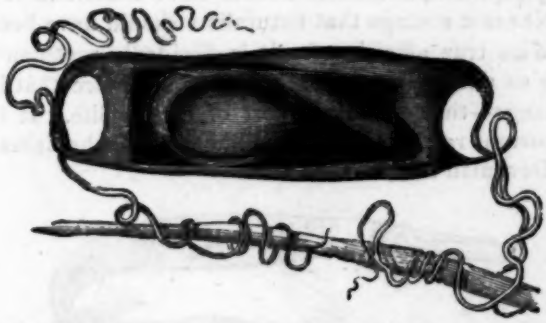

Fig. 8.—Shark's Egg, with a Portion of the Covering removed.

rays? This curious arctic fish, which attains the length of four feet, is not only exceedingly remarkable in its general appearance, but it is especially remarkable in its structure—having no upper jaw, the four

Fig. 9.—Northern Chimæra, or King of Herrings (*Chimæra monstrosa*).

upper teeth being supported on the front of the skull, and only two teeth in the lower jaw, and having no backbone, this important part being represented only by the most rudimentary structure, such as

Fig. 10.—Lepidosiren.

exists in the ordinary embryonic vertebrate, and which is known under the name of chorda dorsalis.

In the tropical regions of America and Africa there is found a strange "fish," about three feet long, and called the lepidosiren (Fig. 10)—scaly siren, as the name implies. In its general aspect it is decidedly reptilian, and some writers have described it under the reptiles. Nor is it strange that naturalists should have been in doubt in regard to its true affinities, for it is decidedly reptilian in appearance, and is so unlike the typical fishes in structure that it has both gills and lungs—thus leading a sort of double life. It is believed that in important respects this fish is like some of the fishes that lived in the old Devonian times.

FIG. 11.—GAR-PIKE (*Lepidosteus*).

The gar-pikes, too, depart considerably from ordinary fishes, especially in their teeth, hard, shining scales, and heterocercal tail (Fig. 11).

And the sturgeons (Fig. 12), ballasted and protected with rows of large bony plates, and with a nose fitted for "rooting," and a mouth

FIG. 12.—STURGEON (*Acipenser oxyrhynchus*, Mitchell).

for sucking, and a tail more or less like that of a shark, are very unlike anything we should select as a typical fish.

And what shall we say of the "sea-horses," or hippocamps (Fig. 13), whose head reminds us far more of the head of a horse than it

FIG. 13.—SEA-HORSE (*Hippocampus Hudsonius*, Dekay).

FIG. 14.—PIPE-FISH (*Sygnathus Peckianus*, Storer).

does of that of a typical fish? And of the pipe-fishes (Fig. 14), or sygnathi, whose body is all length, nearly, and whose mouth is just at the extremity of a long snout; and which have this strange habit,

namely, that the males receive the eggs into a pouch, in which they carry them till they are hatched?

Who that has studied and heard of only ordinary fishes would ever expect to see such an animal as the sunfish (*Orthagoriscus*); and who, when he sees one for the first time, would regard it as anything short of a monstrosity? This huge fish (Fig. 15), weighing, in some

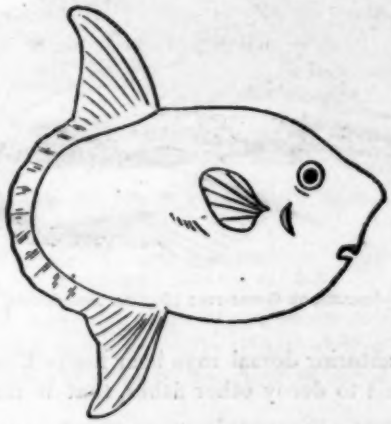

FIG. 15.—SUNFISH (*Orthagoriscus mola*, Schreiber).

cases, five hundred pounds, is so abbreviated behind, that it is scarcely represented behind the dorsal fin, making it one of the most remarkable forms, and one of the most difficult to explain, to be found in the whole class.

The trunk-fishes (Fig. 16) are very remarkable forms. They have an inflexible shield of bony plates, so that the mouth, tail, and fins, are the only movable parts. These small fishes—from three inches to

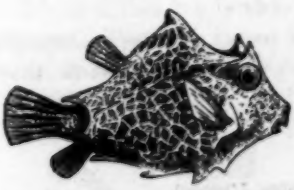

FIG. 16.—TRUNK-FISH (*Lactophrys Camelinus*, Dekay).

FIG. 17.—PUFFER (*Tetraodon turgidus*, Mitcheli).

a foot in length—are thus in strong contrast with the ordinary fishes, whose whole bodies are so flexible that there is the greatest freedom of motion throughout nearly the entire structure.

Again, the puffers (Fig. 17) are remarkable forms. Being more or less covered with spines, and having the habit of inflating themselves by swallowing air, thus giving them more or less of a rounded

appearance, they may perhaps not improperly be called the "sea-urchins" among fishes.

Another strange form is the fishing-frog, or angler (Fig. 18), whose enormous mouth enables it to swallow animals nearly as large as

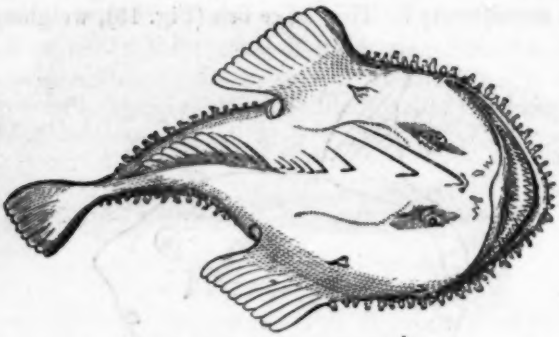

FIG. 18.—ANGLER, OR GOOSE-FISH (*Lophius Americanus*, Cuvier).

itself, and whose anterior dorsal rays bear fleshy filaments, which it is said to use as a bait to decoy other fishes, that it may secure them as food.

In the cavities under stones in the sea are found the little toad-fishes (Fig. 19), whose head is so like that of a toad that we are ready to concede that both the popular and scientific names of these animals (*batrachus*) are well bestowed.

FIG. 19.—TOAD-FISH (*Batrachus tau*, LINNÆUS).

There are many other fishes that depart so much from the ordinary forms that the common fisherman instinctively names them after some land-animals. The sea-wolf or wolf-fish is one of these, although its head is more like that of a wild-cat or a lynx than it is like that of a wolf. It is sometimes called the sea-cat. Its body is long, with a dorsal fin nearly the whole length, and the head is round; its mouth is armed with a most formidable array of teeth, making this animal,

which is five or six feet long, a most dangerous antagonist when the fisherman comes in direct conflict with it.

The hand-fishes of the tropics are very small, but their grotesque appearance and hand-shaped fins, suited for creeping, make them very

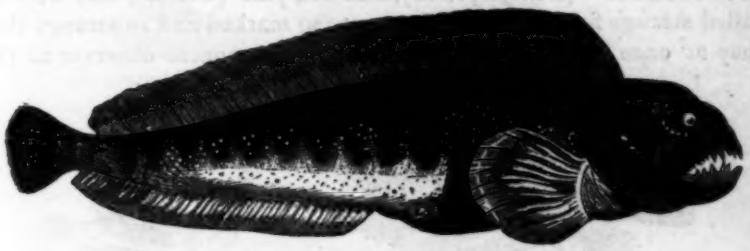

Fig. 20.—Sea-Wolf (*Anarrhichas lupus*).

proper subjects of notice in this connection. One very small species is found on our Atlantic coast.

Nor ought the lump-fish (Fig. 21) to be omitted in this enumeration; for, although it is not specially remarkable in its general aspect, it is very remarkable in at least one portion of its structure. It has

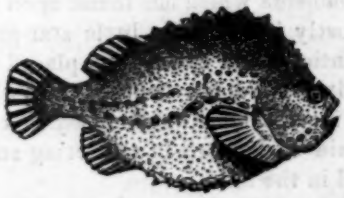

Fig. 21.—Lump-fish (*Cyclopterus lumpus*, Linnæus).

its ventral fins united so as to form a cup-shaped disk, and by means of this disk this fish is able to attach itself to any surface with great firmness. Pennant states that, upon putting one into a pailful of water, it adhered to the bottom so firmly that he lifted it by the fish's tail.

Fig. 22.—Sword-fish.

Nor ought we to omit to mention the sword-fish, although it exhibits nothing specially remarkable in its general form, excepting its sword-like prolongation of the jaw (Fig. 22). And on account of its

movable spine at the base of the tail we may merely mention the herbivorous lancet-fish, although in its general outline it is scarcely more remarkable than a perch or a bream.

"Sea-ravens" (*Hemipterus*, Fig. 23), "sea-robins" (*Prionotus*), "sea-swallows" (*Dactylopterus*), and sculpins (*Cottus*), may well be called strange fishes, for their forms are so marked and so strange that they at once arrest the attention of the commonest observer at the

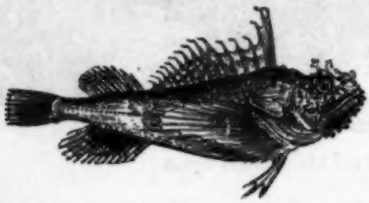

FIG. 23.—SEA-RAVEN (*Hemipterus Acadianus*, Storer).

FIG. 24.—STAR-GAZER (*Uranoscopus anoplos*, Cuvier).

sea-side. While all these have a certain general resemblance to one another, all agreeing in being remarkably ugly, each has its own marked peculiarities in the development of the head and fins, and in the curious fleshy filaments which are found upon some of them.

We may also justly include the little star-gazers (*Uranoscopus*, Fig. 24) of the Atlantic, whose eyes are so placed that they appear as if looking constantly toward the heavens, and whose mouth is cleft vertically, and has in it a long filament which can be protruded at will, and which is said to be used in attracting small fishes while the owner lies concealed in the mud.

Next we may mention the remora (Fig. 25), on whose head there is a sort of disk composed of laminæ which are serrated and movable, by means of which the fish can firmly attach itself to other animals.

FIG. 25.—REMORA (*Echeneis*).

It is said that it can be made useful by putting a ring attached to a line around its tail, and then allowing it to swim away in search of a victim; when it has firmly attached itself to a fish, both the remora and its captive are hauled in together.

Remarkable and strange as are all the forms of fishes which we have so far noticed, not one of them exhibits any want of bilateral symmetry. But we now come to a whole group of fishes, including

halibuts, turbots, soles, flounders (Fig. 26), etc., whose two sides are totally unlike—a peculiarity which is not only not found in any other

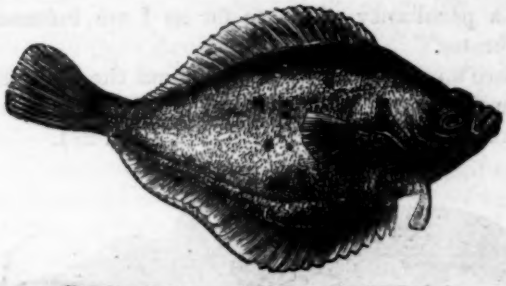

Fig. 26.—Flounder (*Platessa vulgaris*, Cuvier).

group of fishes, but not in any other group of vertebrate animals. These strange fishes have the body flat, both eyes on the same side

Fig. 27.—Gar-fish (*Belone truncata*, LeSueur).

of the head, and the sides of the mouth unequal. They are without a swimming-bladder, live at the bottom of the sea, and are of all sizes,

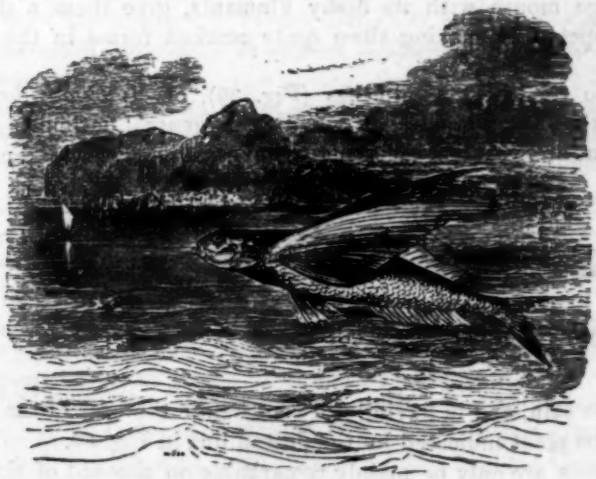

Fig. 28.—Flying-fish (*Exocætus*).

from those not more than six or eight inches in length to those that attain a weight of six hundred pounds.

As for the gars, I should not mention them in this article, although they are quite peculiar in several respects, were it not for one fact connected with the nature of their skeleton. Their bones are of a green color, a peculiarity which, so far as I am informed, is unique among vertebrates.

Nor is there anything very peculiar about the flying-fishes, except the excessive development of their pectoral fins, and the habit of "flight" connected with this development (Fig. 28).

FIG. 29.—CATFISH (*Silurus glanis*).

But perhaps we ought not to omit to mention the siluroids (Fig. 29), or catfish, for, although they are more like ordinary fishes than some of those already mentioned, their large, broad, and flat head, and large mouth with its fleshy filaments, give them a decidedly *outré* appearance, making them quite marked forms in the class of fishes.

As to the little blind-fishes (Fig. 30), or *Amblyopsidæ*, of the Mammoth Cave, they are very similar in general outline to ordinary fishes, but are peculiar in having the eyes rudimentary and concealed

FIG. 30.—BLIND-FISH (*Amblyopsis spelæus*, Dekay).

FIG. 31.—LAMPREY (*Petromyzon Americanus*, LeSueur).

under the skin, and in having the vent before the base of the pectoral fins at the point indicated by the dotted line in Fig. 30.

The eels are only or mainly remarkable on account of their elongated form. But the lampreys (Fig. 31), though eel-like in form, are not only different from ordinary eels in their structure, but very different from all the fishes we have hitherto noticed. Their respiratory

apparatus is very peculiar, being composed of seven pouches on each side, which receive water from the lateral openings of a canal distinct from the œsophagus, and discharge the same through seven branchial openings on each side of the neck; and their mouth and tongue are more strange than their breathing-apparatus. The mouth is round, and the tongue moves forward and backward in it like a piston, thus enabling the animal to produce a vacuum to fix itself firmly to a stone or any other body in the water.

As we get near the bottom of the scale in the examination of fishes, we find forms which, so far as their general outline is concerned, give no intimation of their true affinities. The myxines, or hags (Fig. 32), are of this sort: small fishes which have the general aspect of

Fig. 32.—Hag, or Myxine (*Myxine limosa*, Girard).

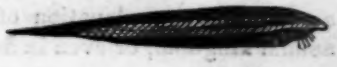

Fig. 33.—Lancelet, or Amphioxus (*Branchiostoma*).

worms, but whose plan of structure shows them to be vertebrates, and whose circular mouth and piston-like tongue ally them to the lampreys.

And at the very bottom of the group of fishes we find the little amphioxus, or lancelet (Fig. 33); and how wide is the gap between this soft, nearly transparent vertebrate, without teeth or jaws, without skeleton or real head, and with only a mere slit for a mouth, and the typical fish as we see it in the shad, the cod, and the salmon! So little does the amphioxus appear like even a vertebrate, that Pallas, the naturalist who first described it, thought that it was some sort of slug or snail.

These strange forms of fishes are facts; and the important question is, What do they mean? What has caused them? What are they for? Will they continue? These and other questions quickly suggest themselves, and are easily asked; but are not so easily answered.

The whole subject of the origin and meaning of organic forms is a very important one. It is not so narrow as indicated by the questions asked above about the queer forms of certain fishes; but it is a subject which embraces inquiry into the origin and full significance of all organic forms upon the earth and within its crust.

Are these fishes and all other organic forms just as they were created? The creationist says "Yes;" the evolutionist says "No." Suppose we admit the doctrine that they were all created as they now appear—what does it mean that there are 15,000 specific forms of fishes, and that a thousand, or two thousand, more or less, are of these *outré* forms described above? Can any one give a satisfactory an-

swer? Or suppose we accept the doctrine of evolution and natural selection—does that, when we come right down to the facts as revealed in these 15,000 forms of fishes and all other organic forms, solve all the difficulties for us, or enable us to solve them? Does evolution alone enable us to account for the wonderful diversity of form, to say nothing of the scarcely less wonderful diversity of size, among these numerous vertebrates—especially when we remember that thousands of the most diverse forms have always been under essentially the same physical conditions?

Is there any rational explanation that we can yet give of such a form and structure as those exhibited in the torpedo (Fig. 4), in the sawfish and the hammer-head shark (Fig. 7), the chimæra (Fig. 9), the remora (Fig. 25), or the lamprey (Fig. 31)?

Is it not true that we have much yet to learn before we can give a satisfactory explanation of the wonderfully diverse forms in the animal kingdom, or even in a single group like that of fishes?

THE OBSERVATORIES OF ITALY.[1]

By Professor G. RAYET.

IN the course of my journey in Italy, I visited successively the observatories of Palermo, Naples, Rome (that of the Roman College as well as that of the Capitol), Florence, Bologna, Modena, Padua, Milan, and Turin, remaining some time at each. There are thus no less than ten observatories in Italy, three times as many as in France; and from the proceedings of the Congress of Astronomers at Palermo[2] it appears that it is the intention of the Government to maintain all of them, each one being devoted, however, to a different branch, so as to fulfill the various needs of astronomical science, now become so complex.

Of these observatories, only that of Naples has a considerable number of assistants, and in no one is the work done under rigid regulations; each astronomer devotes himself, according to his predilections, to a special subject; emulation and the desire to make a name in science produce a continuity of effort the result of which has in

[1] Prof. Rayet, of Marseilles, has recently been deputed, by the Minister of Public Instruction of France, to visit the various observatories of Italy, and to report upon them. His report is published in the *Archives des Missions Scientifiques*, 3me série, tome iii., p. 529. As this work is not generally accessible, and as almost nothing is known in this country of the important steps now taking in Italy, it is believed that the following abridgment and translation of this report will be of value.—Editor.

[2] *See* Appendix to vol. iv. of the "Memoirs of the Society of Italian Spectroscopists," p. 37, *et seq.*

the last few years been manifest in various brilliant discoveries. To show this, it will be sufficient to describe briefly the situation of each observatory, and the work upon which it is at present engaged.

THE OBSERVATORY OF PALERMO: *Director*, M. Cacciatore; *Astronomer*, M. Tacchini.—This observatory contains two important instruments: a meridian-circle, constructed in 1857 by Pistor and Martins (of Berlin), whose telescope has an aperture of 126 millimetres (4.98 inches), and an equatorial by Merz (of Munich), of 24 centimetres (9.45 inches) aperture, which, though built in 1857, was not mounted until 1865. The meridian-circle was employed in 1870 to determine the difference of longitude between Naples and Palermo, this last point being the fundamental station in the new topographical map of Sicily, and it is daily employed in observations of the sun and the principal stars. The most important work, however, of the observatory of Palermo, which is specially undertaken by M. Tacchini, is the daily study of the solar protuberances.

Since the total solar eclipse of 1868, a great number of astronomers have devoted themselves to the daily observations of these protuberances, in order to study their distribution on the solar circumference, and their relations with solar spots. Among these astronomers are Lockyer, Secchi, Rayet, Respighi, Tacchini, and Young, but it is in Italy that these researches are most vigorously prosecuted, and, in order to avoid the interruptions in a series which cloudy days may occasion, the observatories of Palermo, Rome, and Padua, prosecute these observations in common.

Every day, when the weather will permit, M. Tacchini makes a drawing of the protuberances surrounding the border of the sun and of the spots and faculæ which are upon its surface. These drawings, as well as those made at Rome and Padua, are subsequently published in the "Memoirs of the Society of Italian Spectroscopists," whose publications, begun in 1872, form already four large quarto volumes.

For this work, M. Tacchini makes use of the large equatorial of the observatory, and a direct-vision spectroscope made by Tauber, of Leipsic, which has two series of five prisms. These prisms are of rare excellence, for, in spite of their number, the spectral lines suffer no distortion. The spectroscope can be rotated on its axis so that it can be placed tangentially on any portion of the sun's circumference. Among the interesting historical instruments of the observatory is the altitude and azimuth circle made by Ramsden in 1788–'89, which served Piazzi in the preparation of his great catalogue of stars.

THE OBSERVATORY OF NAPLES: *Director*, M. de Gasparis; *Astronomers*, MM. Fergola, Brioschi, and Nobile.—The observatory of Naples is the most important of those of Italy, in its equipment and its personal establishment.

It was founded in 1812 by Murat, and it is built in agreement with

modern ideas. It contains numerous instruments which are maintained in perfect order by the care of an instrument-maker attached to the observatory. In the west meridian room are a transit-instrument by Reichenbach (aperture 117 millimetres = 4.61 inches), and a meridian-circle by the same artist (aperture 108 millimetres = 4.25 inches). These are still in use, and by means of them M. Fergola has lately determined the differences of longitude of Naples with Rome and Palermo. The east meridian room contains a meridian-circle by Repsold, which has just been mounted, and which is one of the best instruments of this class made by this celebrated artist. The telescope has an aperture of 163 millimetres (6.42 inches), and a focal distance of two metres (8.74 inches). It has a single graduated circle, one metre (39.37 inches) in diameter, and four microscopes.

It is with this instrument that M. Fergola is observing the zone of stars which the observatory of Naples has undertaken for the German Astronomical Society. Besides the three meridian-instruments the observatory of Naples has in active use two equatorials, and is soon to obtain a third of larger dimensions. The first of these instruments was constructed in 1811 by Reichenbach and Utschneider, and has 83 millimetres (3.27 inches) aperture. It is with this small instrument that M. de Gasparis discovered nine asteroids, *Hygea*, *Parthenope*, *Egeria*, *Eunomia*, *Psyche*, *Massalia*, *Themis*, *Ausonia*, and *Beatrix*. The second equatorial was made by Merz, of Munich, and has 134 millimetres (5.28 inches) aperture, and 2.06 metres (81.10 inches) focal length. The objective is of so perfect a figure that, in spite of its small dimensions, M. Nobile has been able to employ it in the measurement of double stars of Struve's catalogue. (These were discovered by Struve with an objective of 9.62 inches aperture.)

Observatory of the Roman College: *Director*, Padre Secchi; *Astronomer*, Padre Ferrari.—The observatory under the direction of Padre Secchi is built upon the top of the cupola of the church of St. Ignatius, near the Corso; but in so solid a way that the stability of the instruments, during the night at least, is quite satisfactory. The principal instrument of the observatory is an equatorial of 7.5 inches aperture, which is one of the *chefs-d'œuvre* of Merz. There is still another equatorial, by Cauchoix, of five inches aperture, which is used for the daily observations of solar spots, and also a transit-instrument by Ertel (aperture 92 millimetres = 3.62 inches), for time-determinations. The situation of the observatory, in the centre of the city, has forced its illustrious director to devote his efforts to the study of physical astronomy, which in his opinion is too much neglected in government observatories.

To enumerate the magnificent works executed in this branch of astronomy by Padre Secchi would require too much space, but I may mention a new experimental method used by Padre Secchi in his studies of the solar protuberances. For more than a year he has

employed in place of the prisms of his spectroscope a diffraction-grating ruled upon speculum metal by Lewis M. Rutherford, Esq., of New York City. This grating has 4,000 lines to the English inch, and gives a spectrum whose definition leaves nothing to be desired. For the study of the solar prominences such a grating appears to me infinitely superior to any combination of prisms.

OBSERVATORY OF THE CAPITOL: *Director*, M. Respighi; *Assistant*, M. Scarpellini.—The second observatory in Rome, that of the Capitol, is under the patronage of the *Accademia dei Nuovi Lincei*. It is placed upon the summit of the southeast portion of the palace of the Capitol, and it is sufficiently removed from the neighborhood of traveled streets to preserve it from the vibrations caused by carriages, etc. The instruments are undisturbed enough to allow of the most delicate astronomical observations, such as the determination of the nadir-point and the observation of stars by reflection from the surface of quicksilver, at all hours of the day.

The horizon is also entirely free, so that if the situation allowed of a more regular placing of the instruments it might be considered as very favorably situated for the making of observations of precision. M. Respighi is now occupied in observations of solar protuberances, and in meridian observations, which are to serve as a basis for a catalogue of stars. For the first purpose an equatorial by Merz, of four and a half inches aperture, and a direct-vision spectroscope with five prisms, are employed.

A beautiful meridian-circle by Ertel serves M. Respighi for his observations of those fixed stars of the first six magnitudes, which are to be employed by the Italian staff-officers in their geodetic operations. This observatory possesses also a reflex zenith-tube, made by Ertel from designs by M. Respighi himself. It is a sort of transit-instrument, with an aperture 108 millimetres (4.25 inches), provided with an eyepiece which contains three groups of declination-wires. The basin of quicksilver, by means of which the reflected stars are observed, is 21 metres (68.90 feet) below the objective, which thus masks but a small portion of the sky. When the telescope is directed toward the nadir stars very close to the zenith may be observed by the declination-wires during their transit; at the same time and without touching the instrument the nadir may also be observed, so that the zenith-distance of each star depends upon the micrometer-screw alone and is determined with the great accuracy which this kind of observation allows.

OBSERVATORY OF FLORENCE: *Assistant*, M. William Tempel.—The old observatory of Florence, formerly presided over by Donati, has been dismantled, and a new and magnificent structure is nearly built at Arcetri, near the house formerly inhabited by Galileo. The old observatory is now used for a meteorological station, under charge of Prof. Pitti.

The new observatory possesses: 1. A Fraunhofer equatorial of three inches aperture, suitable for a comet-seeker; and, 2. A large equatorial by Amici, of eleven inches aperture, of excellent quality. Besides this, a small meridian-instrument is mounted in the meridian-room. This room will subsequently contain a meridian-circle of seven inches aperture, and a transit-instrument somewhat smaller. It is proposed to have for this observatory a staff composed of a director and five assistants.

Observatory of Bologna: *Director*, M. Palagi.—The observatory of the University of Bologna is one of the most ancient in Italy, and, like all the observatories of the past century, it is placed on the top of a high tower, which unfits it for precise observations. In the plan proposed for the reorganization of the Italian observatories, this institution is to devote its labor to observations of physical astronomy. It possesses a meridian-circle, by Ertel, of forty-two lines (3.5 French inches) aperture, mounted in 1851, but now little used, and also a Dollond equatorial of three inches aperture. Its collection of historical instruments is of high interest.

Observatory of Modena: *Director*, M. Ragona.—Modena is an astronomical city, for in it or near it were born Amici, Secchi, Tacchini, Ferrari, and other Italian astronomers. The Ducal Observatory is, like that of Bologna, in a transition state. It was founded in 1819, by Bianchi, and was provided with the best instruments of that time, but it now will probably become the central meteorological station of the surrounding states. Its meridian-circle is of four inches aperture with three-feet circles, and was made by Fraunhofer and Reichenbach in 1819, but requires some changes to bring it up to modern requirements. Its Amici equatorial has two and one-third inches aperture only, and is thus too small for most astronomical purposes. Its collection of meteorological and magnetic apparatus is, on the contrary, very complete and noteworthy, and has been made, in most cases, upon plans furnished by M. Ragona.

Observatory of Padua: *Director*, M. Santini; *Astronomer*, M. Lorenzoni.—This observatory dates from 1774, when this city was placed under the protectorate of Venice, and when this powerful republic attracted the most celebrated professors to its university. It is well situated for observations of precision, as the numerous catalogues of stars published by its celebrated director, now the oldest living astronomer, testify sufficiently. The principal instruments of the observatory are a meridian-circle and an equatorial, both by Starke—the first of 117 millimetres (4.61 inches) aperture and with one-metre (39.37 inches) circles; the second with twelve centimetres (4.74 inches) aperture and two metres (78.74 inches) focal length. There is also a spectroscope by Hoffmann. The two latter instruments are used by Lorenzoni for daily observations of the solar protuberances. The meridian-circle is employed in observations of the sun,

planets, and the principal stars, and can even observe stars down to the tenth magnitude by means of a peculiar device for bright wires.

Observatory of Milan: *Director*, M. Schiaparelli; *Astronomer*, M. Celoria.—The Milan Observatory is one of the most ancient of Italy, its foundation in the Brera Palace having been established in 1760. Among its directors have been the celebrated astronomers Boscovich, Oriani, Cesaris, and Carlini. The Ephemeris of Milan has long been distinguished for its accuracy, and for the memoirs published in connection with it by Oriani, Cesaris, and Schiaparelli. The observatory contains two halls, one for the equatorial and one for the meridian-circle. The equatorial, by Merz, was mounted in February, 1875. It has an aperture of 218 millimetres (8.58 inches), and a focal length of 3.20 metres (125.99 inches), and its objective is of such an excellence that a magnifying power of 700 diameters is habitually used. It is to be devoted to a reobservation of Struve's double stars. The meridian circle is by Starke, and has an aperture of four inches and a focal length of five feet.

Observatory of Turin: *Director*, M. Dorna; *Assistant*, M. Charrier.—The present observatory of Turin was constructed in 1820, and until 1864 it was under the direction of the illustrious Plana; since that time it has formed part of the university, and is under the charge of the Professor of Astronomy. Its instruments are: 1. A meridian-circle by Reichenbach, with a circle one metre (39.37 inches) in diameter, and a telescope by Fraunhofer, twelve centimetres (4.74 inches) in diameter. This excellent instrument is used for observations of the sun and stars for the determination of the time, which is given to the city by means of a time-ball. 2. A comet-seeker of twelve centimetres (4.74 inches) aperture and eighty-two centimetres (32.28 inches) focal length, mounted in a small dome. 3. A repeating circle, by Ertel, used for purposes of instruction. 4. An equatorial of 117 millimetres (4.61 inches) aperture and 1.82 metres (71.65 inches) focus, which will be used by Dr. Charrier for spectroscopic observations of the solar protuberances. A larger equatorial is soon to replace this.

In terminating these short notes I must formulate in a few words the reflections which my visit to so many institutions has suggested to me. The simple enumeration of the instruments would ill suffice to judge of their importance. It is not sufficient that an observatory should be provided with numerous or powerful instruments: it is further necessary that these instruments should be at the service of accomplished astronomers earnest in the pursuit of their studies, and having no other desire than to achieve a name in science. In all these respects the observatories of Italy leave the most satisfactory impression upon the visitor. Thanks to this universal ardor, no moment is

lost; and Italian astronomy, which for a time languished, is reconquering with marvelous rapidity the rank which the labors of Galileo assured to it at the beginning of the seventeenth century.

ON DROPS.

By A. M. WORTHINGTON.

AMONG the many ways in which electricity is called in to give assistance in various physical investigations, one of the most elegant and interesting is the application of the electric spark to render momentarily visible a body that is rapidly moving or changing its form. The duration of the electric spark is so short—probably not more than $\frac{1}{14000}$ of a second—that a body, such as a rotating wheel or oscillating rod, moving in a dark room with extreme rapidity, will, if illumined by an electric spark, seem stationary, since the wheel or rod has not time to change its position appreciably during the short instant for which it is visible. If the spark be bright, the impression is left on the eye long enough for the attention to be directed to it, and for a clear idea to be formed of what has been seen.

The writer of this article has recently applied this method to watching the changes of form in drops of various liquids falling vertically on a horizontal plate. As usually seen, a drop of water falling

FIG. 1.

FIG. 2.

from a height of ten or twelve inches on a smooth solid substance, such as glass or wood, seems to make an indiscriminate splash. The whole splash takes place so quickly that the eye cannot follow the changes of form; the impression made by the last part of the splash succeeding that of the first part so quickly as to confuse it.

A little careful observation, however, shows that the drop passes through very definite symmetrical forms, and that a splash is by no means an irregular, hap-hazard phenomenon.

Let the reader let fall a few drops of milk, about $\frac{1}{4}$ inch in diame-

ter, on a smooth dark surface of wood or paper, from a height of, say, six inches (milk is better than water, as it is easier to see, especially on a dark ground); he will observe that the liquid makes a blot with a more or less regular undulated edge, but the splash is too quick to follow with the eye.

Fig. 3.

Let him now substitute a drop of mercury for the milk. By watching the splash very intently he will be able to catch a glimpse of the mercury spread out in the symmetrical, star-like form of *e*, Fig. 9. After the drop has been thus spread out it recovers its globular form, since the mercury does not wet the plate. On increasing the height of fall a few inches, it will be noticed that small drops split off in a more or less complete circle, and are left lying on the plate, while the rest of the drop gathers itself together in the middle of the circle.

The chief reason why these appearances could not be seen with milk is, that the milk wets the glass or wood and sticks to it, while the mercury does not. But by smoking a slip of glass or card tolerably thickly in the flame of a candle, we get a finely-divided surface of lampblack to which the milk does not adhere any more than the mercury, and by very careful watching we may notice that the same radial star is formed by the milk, but it is much more difficult to catch sight of than the mercury-star. But if the mark on the lampblack be examined after the drop of milk or mercury has rolled away, it will be found to consist of delicate concentric rings with number-

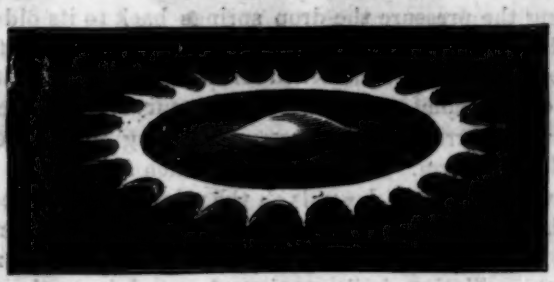

Fig. 4.

less fine radial striæ where the smoke has been swept away. These may be seen very well by holding the glass plate up to the light if it has not been too thickly smoked.

The marks thus made are very beautiful and symmetrical, and it will be found, if the glass be uniformly smoked, that the same-sized drops of the same liquid falling from the same height will produce almost exactly similar marks: while if the height be changed the mark on the lampblack will be somewhat changed; and it is a fair inference, if each drop makes almost exactly the same complicated, symmetrical mark, that the splash of each drop takes place in almost exactly the same way.

The glimpse that may be caught of the drop in the way described is obtained when the drop is really almost stationary, having flattened itself out on the plate, and being on the point of contracting again to its original form.

That a drop if so flattened out will recover itself, is seen on pressing down a drop of mercury with the finger, or a drop of water with a piece of black-lead or other substance to which it does not adhere.

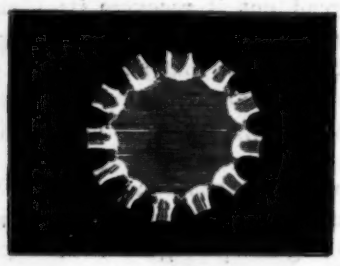

FIG. 5.

FIG. 6.

On removing the pressure the drop springs back to its old form; the force which causes this being exerted by the curved surface of the liquid at the edge of the flattened drop, on the liquid within. The flatter the drop becomes the greater is the curvature of the edge, and the greater the corresponding pressure tending to restore it to its original globular form. The extent to which a drop that has fallen on a plate will spread out depends on the velocity with which it strikes the plate, i. e., on the height of fall; so that as long as the drop returns to the globular form the whole phenomenon of the splash may be regarded as an oscillation similar to that of a pendulum; the velocity of the liquid outward being checked, overcome, and finally reversed by the ever-increasing pressure of the curved edge, just as a pendulum has its velocity checked, overcome, and finally reversed, by the action of gravity.

It is only when the height of fall is very great that the liquid flies off in all directions and the splash ceases to be an oscillation; this

case corresponds to that of a simple pendulum started with a blow so violent as to break the string.

But the liquid star and the complicated pattern on the smoked glass show that the splash is not a simple spreading out of the drop equally in all directions, to return again.

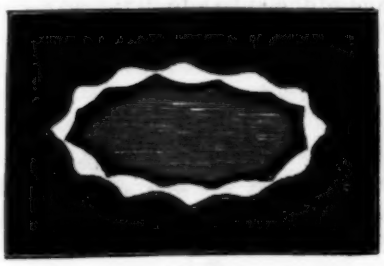

FIG. 7.

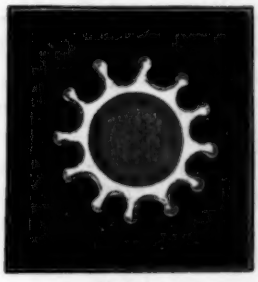

FIG. 8.

In order to observe the form of the drop at any given instant during the splash, it is necessary to make use of the electric spark, and to take advantage of the fact that drops of the same size falling from the same height will all behave in the same way.

It will be necessary to let a drop, say of mercury, fall on a plate in comparative darkness, and to produce a strong spark at the instant the bottom of the drop comes in contact with the plate, and so illumine it; the observer will then see the drop in the form it has at that instant.

A second drop must be let fall in the same way, and be illumined by the spark not at the first moment of contact, but a shade later, say $\frac{1}{100}$ second later, when the drop will have spread itself out slightly on the plate; and similarly we must illuminate a third drop a shade later than the second, and so on. The observer can, after a little practice, draw from memory on each occasion the drop in the form in which he has seen it. It will be seen that the process consists in isolating consecutive phases of the splash from those that precede and follow, and which take place in darkness, and so do not confuse what has been seen as they would do in continuous daylight.

The device adopted by the writer for so timing the appearance of the spark as to illumine the drop at any desired phase of the splash consisted essentially in breaking the current of an electro-magnet at the instant the drop began to fall; the magnet, thus ceasing to act, releases a spring which immediately begins to pull the terminal wire of a strong electric current out of the other terminal, which is a cup of mercury, and the strength of the spring and the depth of immersion of the wire in the mercury are so adjusted that the wire leaves the surface of the mercury, and the required spark is produced at the instant the drop reaches the plate.

For the next drop the spark is made to appear a shade later, either by slackening the spring or increasing the depth to which the terminal wire is immersed in the mercury.

The accompanying figures have been drawn in the way described, and show the behavior of a drop of mercury about ¼ inch in diameter, falling from a height of about three inches on to a glass plate. Each figure represents a rather later stage of the splash than the preceding.

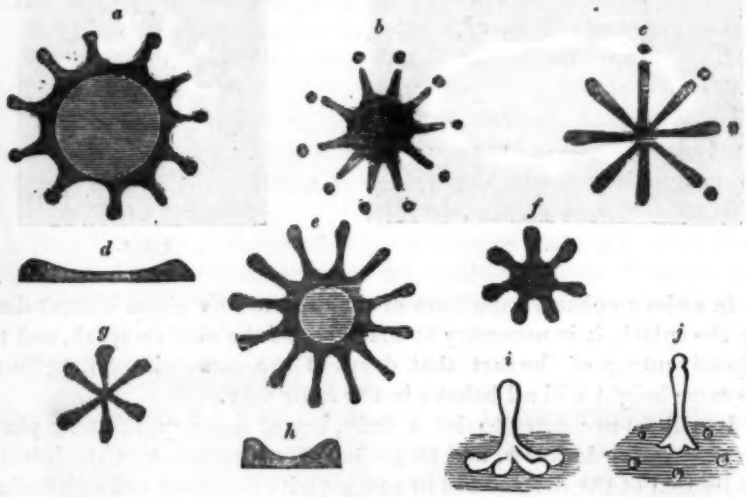

FIG. 9.

Fig. 9 was drawn from the final stages of a milk-drop ¼ inch in diameter, falling four inches on to smoked glass; but the forms are almost identical with those of mercury. Of these *d* and *h* are vertical central sections of the middle part of the drop, while *e* and *f* are alternative forms of *b* and *c*.

From the ends of the rays of Fig. 4, usually twenty-four in number, small drops often split off. These are not shown in the figure. One of the most curious features of the phenomenon is the transition from twenty-four rays to twelve arms, shown in Fig. 5. The beauty of many of the forms, especially of the ridged, shell-like form shown in Fig. 4, when composed of shining quicksilver apparently rigidly fixed, is very striking. Very similar forms are obtained with milk, but, whether with milk or mercury, are liable to occasional variations. For a more detailed account the reader is referred to the "Proceedings of the Royal Society," Nos. 174 and 177, 1876–'77.—*Nature.*

CIVILIZATION AND MORALS.

By J. N. LARNED.

IN bringing these two subject-matters of thought into conjunction with one another, I wish, if possible, to set them clear of all controversy at the outset. No attempt at a definition for either can escape dispute; but a merely indicative statement may be made in each case that will give form enough to the conception without touching any point of question in it. If I should say, for example, with Mr. Emerson, that civilization is "a certain degree of progress from the rudest state in which man is found," I should provoke the disputes that are rife as to what is and what is not "progress" for the human race. But I may safely say that civilization is a certain cumulative succession of modifications or changes in the state and character of men—which indicates the conception quite distinctly enough, and excludes every matter of debate. In like manner I may avoid the disputations of the ethical schools, and yet set out a notion of morals that will serve every present purpose of thinking, if I say that moral philosophy has for its subject *human conduct*, considered with reference to whatever *absolute qualities* may be found in it. It might seem, on the first thought, that this statement assumes the very thing that is in question between those who contend for the absoluteness and those who contend for the relativity of our ideas of right and wrong. But it is not so. The dispute of the moralists has reference, not to any characteristic of the qualities in conduct which we cognize as *moral*, but to the mode in which they are cognized. Our conception of such qualities involves the conception of absoluteness in them, and it is only by that notion of absoluteness that they are distinguished from the other qualities which appear in human conduct, such as wisdom, prudence, ingenuity, and the like. The imperative "*ought*," which puts its mark upon what is moral, in distinction from what is prudent or expedient, is just as autocratic in the doctrine of the utilitarian as in that of the intuitionist. The former, as Mr. Sidgwick has pointed out in his admirable analysis of "The Methods of Ethics," can only hold that the moral rules of conduct are means relative to an end (greatest happiness) by holding that the end itself is prescribed absolutely, and *ought* to be pursued. But absoluteness of end involves absoluteness of means, since means and end are inseparable—so far as human knowledge goes—and cannot be conceived of apart. Hence the qualities in conduct which the utilitarian finds essential to the attaining of the object that represents "duty" to him are just as absolute in his view as in the view of the intuitive moralist, who admits nothing objective in his notion of "duty." In what I have to say,

therefore, of that kind of quality in human conduct which we call "moral," I shall distinguish it only by its absoluteness.

Every act in the conduct of a human being is incident to some one or more of the varied relationships by which his state of being is conditioned. Fundamentally, there are four groups of such relationships, subject to which every act of man is performed: 1. His relationships to inanimate Nature, or to the matter, the forces, and the routine processes, of his physical environment; 2. His relationships to the living creatures with which he is associated in existence, that are not of his own kind; 3. The relationships that exist within himself, between the manifold parts of his own being; between that, for example, which is animal on one side and that which is more than animal on the other; 4. The relationships that exist between himself and his human fellows.

It might be expected, perhaps, that I should add a fifth relationship—that of man to the supreme source of being and of law in the universe; but this lies at the outside of what we are now investigating. It is a relationship to which nothing in human conduct can be incident primarily, however powerful an influence upon conduct may be referred to it secondarily. The emotions of religion, induced by a conscious relationship of responsibility to some supreme, divine government in the universe, give a color of their own, it is true, to the quality of human acts, but they do not assume to impart that quality nor to change it. Primarily, they have nothing to do with it—it is determined independently of them—and Religion has to do with the quality of human actions only by adopting the colder consciousness on which Morality is founded, and suffusing it with the warmth of reverential and impassioned motives.

Of the four groups of relationships to which all conduct is incident, the one first named does not fall within the region of morals, and the second only touches upon the borders of it. Without entering into the reasons of the fact, it may be seen that the kind of quality we are looking for in human actions cannot exist where the act is entirely conditioned by purely physical laws, as in the case of a man's dealing with the inanimate world. As he stands related to brute creatures, however, one new factor is introduced, which is that of sentiency, on the opposite side of the relationship, as well as on the side of the human actor, and we find in the conduct incident to this a single quality which we recognize as of absolute existence—inhering in the very nature of the act to which it pertains. For the positive phase of this quality, which is not exactly kindness and not exactly mercifulness, no name seems to have ever been adopted. In its negative phase we call it cruelty, and it appears to be, among moral traits, the primary one.

In the third group of relationships, embracing those which are

intrinsic in man (as between his ruling faculties and the organs which they rule, or between his reason and his will, on the one hand, and his affections, appetites, and senses, on the other), the field of moral investigation enlarges, but is still limited. There seem to be two forms in which the absoluteness of quality that we are searching after in human conduct is found appertaining to these intrinsic relationships. We have it, I think, in the qualities that we call truthfulness and courage, and I do not perceive it in any others within this category, except such as are no more than modifications and combinations of these, with their opposites. I cannot now go beyond this mere statement of a conclusion, unless it be to suggest that such distinguishable moral qualities as patience, fortitude, resignation, and so on, are modifications of the radical quality of courage; while another order of qualities, like temperance, chastity, and sincerity, have their root in truthfulness, or integrity, which may be the better name. Out of these two radicals there may be derived, I think, by combination and modification, all the qualities which I should classify as the moral qualities of the personal order.

The final set of relationships to be investigated is that which exists between the individual man and his fellow-men; and here the field of moral study opens to its widest dimensions. These social relationships are varied, numerous, and highly complicated by intermixture. It might be supposed that we should have to divide them into two principal groups, embracing—1. Such relations as exist between man and man individually; and, 2. Such relations as exist between the individual man and his fellows at large, in the united body which we call society; but it will be found that a man's relations to society are only the sum of his relations to the several members of it, and that society, in fact, is nothing more to him than a congregation of the persons between whom and himself he comes to recognize that there are relations of human fellowship existing. Nothing new, as a true factor in morals, is introduced by social organization—not even by the institution of government; because that is a mere arrangement for defining (sometimes arbitrarily and incorrectly) the relations between individuals. These relations between individuals, then, are what we have to examine, and they seem to divide themselves as follows:

1. The relationship in which one man stands toward another simply as a living creature. This is identical with the relation existing between man and brute animals, in the conduct incident to which we discovered no moral quality except that of cruelty and its unnamed opposite; and we need not go far in human history to find social states and circumstances in which no other relationship than this is often recognizable between men, and under which no other moral quality can often exist in the conduct that is incident to it.

2. The relationships which one man sustains to another as a human

fellow. These latter are partly *direct* and partly *indirect* or secondary relations.

The *direct relationships* in this case are those of a man to the concrete *person* of his human fellow. These direct relationships are simple and not very numerous, in fact, although they assume countless variations of circumstance and form. Some of them are special, like the relations that exist between parent and child and between husband and wife; some of them are limited, like the relations that exist between the sexes; and some of them are common and universal. In the conduct which is incident to these relationships there has seemed to be a great variety of distinguishable qualities of the absolute sort, and we have a lengthy catalogue of names in the nomenclature of morals to represent them; but I am disposed to believe that, after all, there are only two radical qualities (with their opposites) to be found in this sphere of human conduct. These are benevolence and justice. All the rest, which appear upon the surface as distinguishable moral qualities, I conclude to be either variations of these in degree and by circumstance, or else the resultant of some blending of them with the moral qualities of the other order. Such blending is necessarily incessant, because the relationships under which man is acting are always mixed. Mr. Lecky has given the name of the "amiable virtues" to a considerable group of these moral qualities, such as charity, generosity, magnanimity, mercifulness or clemency, kindness, and so on, every one of which would seem to have its root in benevolence, or in benevolence and justice combined, and to be merely circumstantial modifications of the same essential quality. Then we have, appertaining to this relationship, such qualities as fidelity and honor—if the two are really distinguishable—and both of these are clearly produced by an intermixture of the absolute personal quality of truthfulness with the absolute social quality of justice. Whatever else there may be of distinguishable moral qualities appearing to be incident to the direct relations of human fellowship, I am sure that they will be found reducible to the two radicals of benevolence and justice, or to their combination with those other radicals—courage and truthfulness—which we found to have an intrinsic source in the constitution of man, as qualitative factors in human conduct.

The *indirect or secondary relations* that exist between man and man as human fellows are those which extend to something additional to the person—to things, that is, which have become recognizably identified with the person. In these relationships the whole notion of "property" is involved. The idea of "property" is the idea of a special relation existing between a certain man and certain things, in recognizing which we necessarily recognize—1. That our own relations to those things are modified by it; and, 2. That it introduces a new set of relations between ourselves and the man, which are indirect, because the things in question are intermediate in them. Not only tan-

gible but intangible things become thus associated with the personality of our fellow-man, and give rise to these indirect relationships. His opinions and beliefs, his friendships and his reputation, the objects of his affections, the franchises that he acquires under the artificial institutions of society, are all examples of the intangible things which become intervening subjects and objects in many of the relationships that a man sustains toward his fellow-men. The indirectness of the relationships thus created is productive of great complexity in them, and gives rise to much confusion of moral notions with reference to the conduct that is incident to them. Out of all the complications that arise, however, there is not one distinctly new quality evolved. We distinguish in this region of conduct such absolute characteristics as those of honesty (under many names) and tolerance, but they are all of the composite class, and have their root, for the most part, in justice and truthfulness intermingled, with benevolence sometimes imparting its amiable tone to them.

As the result of our survey, then, we have discovered but four absolute qualities in human conduct that are simple and radical, while we have traced a very few of the numerous qualities that are composite, or derived, to the relationships out of which they arise. We have:

Of radical qualities of the personal order—courage and truthfulness.

Of radical qualities of the social order—benevolence and justice.

Of derived and composite qualities of the personal order—temperance, chastity, fortitude, patience, etc., with their opposites.

Of derived and composite qualities of the social order—two classes, viz.:

1. Incident to direct social relationships: charity, generosity, magnanimity, mercifulness, kindness, fidelity, patriotism, etc., with their many-named opposites.

2. Incident to indirect social relationships: honesty in all its forms, and with all its opposites, which are numerous in the nomenclature of morals.

Having acquired, so far as this, a partly definite notion of morals, we may now return to take up the conception of civilization, and bring the two sets of ideas into conjunction.

I did not venture to say of civilization that it is "a certain degree of progress" in the state of man, because there are those who deny that the cumulative succession of changes, in man and society, which appear in the process called civilization, are, on the whole, progressive changes. Their denial, moreover, has reference entirely to the moral features of the process. They do not question the fact that human history, in the civilized communities, is a history of intellectual development and advancement. They concede the largest claims that can be made as to the growth of knowledge among men; as to the

growth of capacity in them for the knowledge of knowable things; and as to the growth of power in them to control the material conditions of their existence, within such limits as are set by physical law. They do not belittle the modern triumphs of the race in commerce, science, art, invention, and organization. But they look upon all this as an evil, delusive, vainglorious show—a devil's work of tinsel and veneer—a bubble-blown fabric, quite empty of the substance of eternal things. They insist that there has been no moral growth in human nature, as a whole, to accompany the evolution of rational faculties and powers; and that, while human conduct has been gathering its potent gains of prudence, ingenuity, skillfulness, and the like—which are qualities relative to means and ends—it has gained, on the whole, in the absolute qualities of rightness and goodness, either nothing at all or less.

This denial of moral progress, as a general fact, is made, however, with some necessary qualifications. There are certain moral fruits so conspicuous in the history of civilization, that no pessimist can dispute them. That the long, slow movements in society, which have been tending, with steady purpose and sure result, to establish order and the reign of equal laws; to extinguish slavery; to break oppression of every form; to mitigate the barbarities of war, and to put restraints upon it; to diminish human suffering; to help the unfortunate, and to lift the debased; to cultivate the cosmopolitan sentiment and the spirit of coöperation among men—that the movements which bear this ripening fruitage are moral movements, it is impossible to deny. However the sullen pessimist may disparage them, as sentimental and superficial, the moral quality in them is unmistakable. He yields, therefore, to the evidence of a moral growth of human character in these amiable directions, but he contends that it is all awry, and more deforming than otherwise in the result. He points to the other sides of the historical exhibition of humanity, and asks us what we can find to please us in the total showing. Is there less hypocrisy among men, he demands to know, than there was twenty centuries ago? Is there less chicanery, less duplicity, less grasping greed and selfish meanness? Is there less rapacity, in fact, after all the rude violence that you have subdued by softer manners is taken out? Is there less ruthlessness in the pursuit of ambitious or avaricious ends? Has any nobler type of character been fashioned by all your schools and institutions than the type of Socrates and Plato? Is your democratic Yankee, with his newspaper, his caucus, his party "platform," and his patent ballot-box, a more admirable patriot than the grim republican of old Rome? Is your modern mechanic, with his cunning tools and his marvelous engines, a more honest workman than the patient cathedral-builders of the middle ages? Is your modern merchant, with his steam carriers, his electric messengers, and his bills of credit, a more scrupulous speculator than the camel-driv-

ing trader of old, who fetched and carried between Babylon and Tyre? Such questions as these are not easy to answer, and very few persons will be willing to meet them with affirmations, in any positive and unqualified way.

We are brought, then, face to face with the fact that there are certain directions in which the process of civilization appears to be much more certainly a process of moral development, as evinced in human conduct and character, than it does in others; certain particulars of conduct, that is, in which the fact of moral progress is undeniable, and certain others in which, at least, it is open to doubt. Now, this is assuredly a fact of great significance. For the inference is plain that, if the progress of the race in intellectual culture and in social organization is attended with a certain moral development in some particulars of conduct more distinctly than in others, there must be reasons for this difference, and most likely they will be found in some bearing which the one process of culture has upon the other. It is to pursue this suggestion a little that I have taken the subject up.

The moment we pause to reflect upon the difference in question, one fact concerning it arrests attention. It is this: that the particulars of conduct in which the moral advancement of the human race is most obvious and indisputable are exactly and entirely those which we have seen to be incident to the *direct* relations of human fellowship, and that the qualities developed are entirely those which appertain to that relationship, having their root in benevolence and justice alone. On the one hand, charities, friendships, institutions of kindly helpfulness, and all generous, gentle amenities of social intercourse; on the other hand, charters, ordinances, constitutions—defined equities and broad determinations of personal rights: these are plainly the greater moral fruits of civilization which show signs of approach to ripening, as yet, and they all lie within the domain of those *direct* relationships which exist between man and man as human fellows, and which connect themselves with nothing else.

This fact leads us quickly to the recognition of a second one, which becomes just as plain on examination—namely, that the particulars of conduct in which the moral advancement of mankind appears most questionable are exactly and entirely those which we have seen to be incident to the *indirect* relations of human fellowship; to the relations, that is, which involve some intermediate thing, through which the line of relationship to our fellow is drawn. These take in, as has been said, all the relationships in which "property" is concerned, embracing the whole organization of trade and of labor under hire; and they also take in a great part of the political relationships that arise out of the institutions of government. Now, it is undeniably in these spheres of conduct that the moral effects of civilization present the most discouraging appearance. Are men as honest in work and trade as they were in more primitive times? Is there not more trickish-

ness, more cheating, more fraud, more overreaching, more adulteration, more sham, more outside pretension and inside falsity? Are they as true in political action to the state in which they have united and incorporated themselves? Is there as much genuine patriotism? Is there not more political corruption and neglect of political duty? These are certainly the questions which stagger the optimist most.

Here, then, we discover that the particulars of conduct between which the widest difference of progress in moral culture appears are precisely those that we have already separated by one of the broad differences that were found when we classified the relations to which human conduct is incident. It is natural to conjecture that the one difference may connect itself with the other. It becomes still more natural when we perceive that the characteristic difference which distinguishes the two sets of relationships in question has been widened by the process of civilization. On one side, the *direct*, primary relations that exist between men, in their purely personal attitude toward one another, have been steadily pressed into greater intimacy and closeness, at every step of advance which has been made in the diffusion of knowledge and in the social organization of the race, while they have been more and more generalized in the same operation. On the other side, as the industrial, commercial, and political mechanism of society has acquired more complexity and greater extension, the *indirect* or secondary relations, which involve the fact of property, etc., have been all the time undergoing variation and multiplication, and have been shaped into forms of greater remoteness, as between the persons and the things that are concerned together in them. The effect in the one case has been to set out the relationships in question more clearly, to define them more distinctly, and to render them more easily recognizable as they widen; and it is within the sphere of this effect that we have the progress of moral culture most marked. In the other case the effect has been to obscure most of the relationships in question, and to render the clear perception of them more difficult as they lengthen out; and it is within the range of this effect that we find most doubtful evidences of moral growth in the process of civilization.

From this I shall now venture a generalization, to see whether it will be justified by further scrutiny of the moral history of mankind, and I offer it in the following propositions:

1. That moral notions, or notions of rightness in conduct, are formed in the mind by the perception of certain relations to which human conduct is incident; that they are exactly akin in nature, therefore, to mathematical notions, and have their genesis in the operation of the same faculties; that there is no more need, in consequence, of a special "moral sense" to account for them than there is need of a distinct mathematical sense to account for the perceptions and reasoning processes of arithmetic and geometry.

2. That "rightness" in conduct is just as absolute a quality as "straightness" in mathematical lines (from which it takes its name), and can no more depend for its existence upon the "utility" that is found in it, or upon its coincidence with the experience of happiness among men, than the existence of the quality of straightness in mathematical lines can depend upon the utility with which it serves the architect and the engineer, and coincides with the necessities of mechanical art.

3. That our moral notions of right and wrong, with reference to each particular of conduct, are distinct and complete in exact proportion to the clearness and fullness of our perception of the relations which that particular of conduct appertains to; that their influence in the guiding of our conduct depends upon the distinctness with which they have thus been formed; but that our obedience to the guidance they offer depends upon something else, which we shall have to investigate hereafter.

Let me illustrate these propositions as briefly as possible:

It seems to be historically certain that man's cognition of the *alter ego*, or other "self," with which he finds himself associated in existence at every turn, is slowly acquired at the beginning of it, and that his conception of that other "self" (or fellow-man) is formed gradually by the projection upon it of ideas that have grown in his own self-consciousness. There are social states still existing, as I have said, in which one man's cognition of another seems to be very slightly different from his cognition of brute creatures, and we may take these to represent one of the primitive stages of human development. But progress occurred in the evolution of consciousness, until the attributes of the subjective "self," which it had cognized first, became more or less perfectly projected upon an objective "self," and one man recognized in another a repetition of the same fact of existence which he found in his own being; in other words, he arrived at the recognition, more or less perfectly, of a human fellow. At this stage moral notions and sentiments had their beginning, exactly as mathematical notions began when two external objects were distinguished from one another, and yet cognized together as two instead of one. There would follow some perception of a relation between this conscious "self" and that other cognized "self," and it would be perceived as the definition of a rule of conduct between them, just as surely as there followed in the other case a perception of the relation in position that exists between one object and another, and which conditions every act that involves the two. In both instances the fundamental idea generated by the perception must be the idea of a line—a "line of conduct" in the first, a "line of motion" or a "line of position" in the second—and the quality of "rightness" which attaches to the conception of the one is identical in kind with the quality of "straightness" that attaches to the other.

The golden rule of conduct, "Do unto others as ye would that they should do unto you," is strictly analogous to a mathematical definition; or, rather, it is the translation of such a definition into the language of morals. It is not only the formula of an equation, but it is precisely equivalent to the definition that we give of a right line when we say that only one such line can be drawn between two given points, and that to attempt to project another in reverse direction is only to repeat the first. It simply states the recognition of a corresponding fact—namely, that the line of right conduct projected from my "self" to another "self," which I have cognized, is such that no different line can be projected from that other self to me. What the line of right as projected *to* me from my fellow is, I am taught by my consciousness of the demands that exist in my own being.

In this way men first acquired, perhaps, the notions of right which produced a certain imperfect respect for life and liberty among them, and also a certain respect for property, according to the primitive idea of property, which was a narrow one. But, of course, these notions were restricted to the small social range within which the relations of human fellowship had become even indistinctly recognized. How limited that range was at the beginning, it is impossible to say; but our earliest knowledge of the human race finds it everywhere bounded by associations of kinship. The patriarchal family, the clan, the *gens*, the tribe, seem to have always, at a certain stage in the development of humanity, circumscribed for each man his recognition of other men as human fellows, and his perception of the relations which he sustains to them as such. Within that close circle of recognized relationships, however, we can find in the primitive states of society almost as perfect a determination of moral rights and obligations, so far as many particulars of conduct are concerned, as we find in the civilized communities of the present day. We know that, among the Indian savages of our own time, theft and murder within the membership of a tribe are condemned as distinctly, almost, as they are among ourselves; but as between tribe and tribe, or between Indian and white man, neither killing nor stealing connects itself with any apparent sense of wrong. The fact seems to have been the same in all the earlier tribal forms of society, and when the succeeding form was reached, in the organization of the political state, the larger boundaries of that social corporation still circumscribed the moral notions of its citizens just as rigorously.

In the ancient Gentoo laws of India, which show admirable notions of honesty as between the subjects of the laws, we find prescriptions for dividing the booty of robbers who had plundered any contiguous but alien people. "If any thieves," says the ordinance, "by the command of the magistrate, and with his assistance, have committed depredations upon and brought booty from *another province*, the magistrate shall receive a share of one-sixth of the whole," etc.

In ancient Greece, even at the golden prime of that splendid narrow culture which exhibited itself so incomparably in art, in literature, and in civic virtue, the moral rules which concern liberty and life, and the simpler of the moral rules which concern rights of property, were defined very perfectly as between the fellow-citizens of each state, and between the kindred states, but very imperfectly beyond that strict limit of familiar association. The stranger, the alien, the enslaved captive, the barbarian of the non-Hellenic world, were not human fellows to the Greek; at the most they were only human creatures of some different variety, having that similitude and approaching somewhat to that relation, but quite excluded from his cognition of fellowship by all the habits of his feeling and his thought. According to his perception, they were clearly proper subjects of predatory warfare and piracy; he could kill them, plunder them, enslave them, with no more compunction of conscience than the modern hunter feels in capturing or killing the game-animals of the forest. And yet the same conscience was acting in the Greek that acts in men to-day; but only with more narrowness of range in the perceptions upon which it acted.

We shall have to pass far beyond the Greek in history to find much of a moral change in these respects. The Englishman of the Elizabethan age was a tolerably cultured man, as well morally as otherwise. So far as his fellow-Englishmen were concerned, he had notions of right conduct that were quite accurately formed. But he found it hard to carry many of these notions beyond the shore-bounds of his little island. The sea in that time—not only the Spanish Main, but the English Channel, and the very Thames itself—was swarming with English pirates and buccaneers, who were the contemporaries of Shakespeare, and Bacon, and Spenser, and Coke; who boasted the best names of the English gentry in their ranks; who received more than half countenance from the public sentiment and the public policy of the English nation; and who pillaged Spanish, French, and Flemish traders with serene impartiality, killing captains and crews without remorse when it suited their convenience to kill. In fact, Mr. Froude tells us that the well-encouraged piracy of the sixteenth century was "the very source and seed-vessel" of the future naval power of England.

This insulation of moral ideas, which established one code of conduct for fellow-citizens and another for foreigners, one code for neighbors and another for strangers, characterized every people until recent times; but it has been disappearing rapidly among all the foremost races since the modern growth of universal commerce began. There is no mistaking the reason why. In the footsteps of commerce, every kind of communication and intercourse between men has closely followed, like the threads behind a weaver's shuttle. By travel, by migration, by correspondence—through the post, the newspaper, and the telegraph—men are fetched nowadays from the farthest corners

of the earth into acquaintance with one another. For the civilized man of our time, most of the world has become a neighborhood. He interests himself in the life and doings of another hemisphere much as he does in the affairs of his own town. He cannot help losing the sense of strangeness and of remoteness in his cognition of other men, even though they inhabit the antipodes. He cannot resist the influence of the association into which he is thrown with all men, of all nations, races, classes, and creeds, and he necessarily extends to them, more and more in common, his recognition of human fellowship. In other words, he generalizes more and more his notions of right conduct toward men, because his clear perception of those relations of fellowship upon which such notions are based has become a general instead of a partial one. This accounts for the whole humane movement of modern times toward democracy, toward the breaking of caste and the leveling of class divisions, toward emancipations and enfranchisements, toward equity in institutions and laws, toward common education and toward public and private charities of every kind.

It is not the fact, however, that every man acquires entirely for himself these larger and more intelligent perceptions, which broaden and clarify his notions of right. There is the same giving and taking in this as in other matters of knowledge. Men accept from one another a great deal of what becomes the serviceable common stock of knowledge in every department. We are all of us settled now in the belief that the earth is round, that it revolves about the sun, that it rotates on its axis, that the other planets do the same, and that these motions are all controlled by the same force, under the same law, which governs the fall of a ripened apple from its stem; but how many comprehend the mathematical proofs by which such beliefs as these are sustained? The belief makes its way among men by the force of the authority of the few, whose keener faculties have verified the demonstration of it—assisted, indeed, by the general growth of what may be called a receptive intelligence, which enables men to discern the probability of the truth of things which they do not perceive clearly in fact. But such beliefs are accepted at last and acted upon and reasoned upon, exactly as though they held in each man's mind the firmest ground that his own perceptions and his own reason could give them. It has appeared to be the same with all the larger generalizations in morals. They are diffused in society by the propagation which we call a growth of public opinion, and they sometimes enforce themselves in the moral code of a community even before the major part of its members have half recognized the ground of fact upon which they rest.

If we turn now to the *indirect* relationships between men, which arise out of the institutions of property, politics, etc., we shall see that they have been generally rendered more remote and less recognizable, by the same operations that have produced greater intimacy and fa-

miliar closeness in the *direct* relations of person with person. This fact is particularly apparent in the relationships which involve property. The primitive idea of property was so associated with the fact of possession or occupation that it could not be entertained apart from that. According to the earlier Roman law, stolen property was lost to its owner, simply because he had lost possession, without which the moral intelligence of that age could not retain its conception of the right of property. If recovered from the thief, it was appropriated by the state. In the later Roman jurisprudence this inequity was corrected, but it reappeared in the legislation of the barbarian conquerors of the empire, and again became the law of Europe for several hundred years; surviving in some parts of Germany, according to Chancellor Kent, until near the middle of the last century. By the common law of England, as laid down even so lately as in the Commentaries of Blackstone, goods wrecked were adjudged to belong to the king, and the owner had no right of recovery until a curious statute of Edward II. gave him that right, upon the condition that some living creature should have escaped the wreck, to fictitiously represent him, it would seem, in the act of possession at the last moment.

This strange defect in the primitive idea of the right of property, lingering so obstinately and so long, illustrates the difficulty which men have always experienced in carrying that idea from a simpler to a more complicated set of circumstances, and the easiness with which their perception of the relations to which it attaches becomes confused by any separation, whether real or apparent, of the thing from the person. But, in the evolution of our civilized social state, more complex forms of property have been coming all the time into existence. In some of these, the person and the thing have been pushed apart to a wide remove from one another; in others, the association of ownership between them is subtilely conditioned by various circumstances and contingencies; in others, several persons are associated with the same thing, in common ownership, or with a succession of rights in it, or with rights that are various in degree; in still others, the thing which is the subject of property is a pure figment of the brain—the mere idea of a property-right which has itself become property by a convenient fiction. Again, half the wealth of the world has been acquiring of late a kind of duplicate shadow-form of existence, by paper representation, in a hundred modes—as in bonds, notes, drafts, stock-certificates, bills of lading, etc.—and so plays a double part, one real and one fictitious, in the commercial transactions of the present day. That this protean mobility of form should be given to "property," and the subjects and conditions of ownership be so continually multiplied and modified, without obscuring the indirect relations which "property" creates between men, and confusing the perception of them, is quite impossible. Along with this obscuring cause there is another

one to be found, which has been equally active in the whole arena of industrial and commercial intercourse. This is the constant multiplication of intervening agents—middle-men, factors, brokers, speculators, contractors, and distributors of every sort—between the producer and the consumer, or between the primary owner and the ultimate owner of almost everything which is the subject of ownership and trade. Those two, who are the actual persons brought chiefly into relationship by the thing in question, are put quite out of sight of one another in most of the transactions of modern industry and commerce; and it is easy to see how much more energy in the forming of a notion of right is required to preserve the integrity of the line of conduct between them, through indirect dealings like these.

The truth, then, seems to be that the civilizing process in society has, thus far, had two quite contrary moral effects: one, to cultivate and quicken in men the intelligence which apprehends their relations to one another, and which perceives a right line in all the conduct that is incident to those relations; the other, to complicate and obscure one prominent group of such relations, and to make the apprehension of them more difficult. If the former effect has not yet overcome the latter, in that sphere of conduct where the conflict between them is greatest, there is nothing to wonder at in the fact. It is quite according to the nature of our moral cognitions that men should sooner learn not to steal than not to cheat: because stealing is an assault direct upon that fact of *possession* which we have seen to be at the bottom of the idea of a right of property; whereas cheating takes most of its suggestions from the absence of that fact. It is certain that civilization has diminished downright robbery, depredation, theft, and not so much by its police, nor by the force of its penal laws, as by cultivating the notion of right conduct which condemns them. If it has not yet curtailed the devices of fraud, and if men make dishonest use of the knowledge and the skill that they have gained in every art, even more, perhaps, than their fathers used the scantier methods of fraud which they knew, the reason seems to be explained, and I can find nothing in the fact to argue against a final ripening of moral fruits in this region of human conduct, as well as in the rest.

"But what then?" every reader will ask. "Is it enough to account in this way for our notions of right? Is it enough to satisfy ourselves that they are formed like our mathematical notions, by the same faculties, in the same way, and that they have the same intellectual genesis? Is there not something more which this doctrine leaves still unexplained?—that something which distinguishes a moral notion from every other that is formed in the human mind; that something in it which is mandatory and urgent; that something which we call conscience, sense of duty, obligation?" I say, Yes; there certainly is something involved in morals beyond the knowledge of right and wrong; some kind of a force, or some kind of a law of feeling in man,

which constrains him toward the right line of conduct when he has discerned it. That it only operates in coincidence with his perception of the line of right—that men, in other words, have no conscience with respect to wrongful deeds which they have not yet recognized as wrongful—appears to be shown by all the facts of human history. If it were otherwise, the Greek should have had a conscience to protest against infanticide; the Roman should have had a conscience to protest against slavery and against the bloody games of the arena; the Jew should have had a conscience to protest against the slaughter of women and children in war; Calvin should have had a conscience to protest against the burning of Servetus, and Cotton Mather a conscience to protest against the witch-hunting deviltries at Salem. This conscience, then, must be something that is only made active by the development of a moral intelligence which reveals to men the line of right in one particular of conduct after another. Need we try to account for it any otherwise than by calling it a *law of feeling*, analogous in kind to that law of motion which operates to constrain the obedience of matter to right lines of motion? We know that, when we throw a stone into the air, it would move forever in the straight line of its projection if other forces, more potent than the projecting one, did not interfere to overcome the proper law of its motion. If, now, we might imagine a state of consciousness in this clod of matter, by virtue of which it could *feel* the resistance in itself to the perturbing forces that are swerving it from the line of rectitude, we should have the perfect analogue of what I conceive to be the conscience of the human being; a persistent law of feeling, that is, in man, which resists deviation from the right lines of conduct whenever he has become conscious of them. Such an implanted law of moral feeling in human nature is no more difficult of conception, nor any less so, than the rectilinear law of material motions.

But if the moving stone were conscious of the commanding law which resists all perturbing influences, it would still be irresponsible for its deviations from the right line of motion; whereas the acting man is not, because all the forces, of projection and perturbation alike, are in himself, and within the control of his own volition. He has but to bring his will into conjunction with the resisting *vis inertiæ* in his moral consciousness to make the resistance always efficient.

And this brings to light the third element in morals: which is the discipline of obedience in man to the law of feeling which constrains him toward the right line of conduct when he has perceived it. This discipline is very obviously the final end and final fruit of human culture. We need not wonder that it is slowly attained, when we think of the powerful animality in man which has to be struggled with in the process. It may be that our modern civilization has accomplished little as yet beyond the older in this direction, of moral discipline. It may be that men have acquired larger perceptions of right without

being trained to obey them any better, except in a few directions of conduct, where the least resistance of opposing appetites and passions is encountered. But still it must be true that all culture tends, first, to develop the moral intelligence which forms right notions of conduct, and, finally, to perfect the moral discipline which makes conduct obedient to them.

It is upon that discipline chiefly that those qualities which I have called the moral qualities of the personal order, and which have their root in truthfulness and courage, depend for their evolution. I had intended to recur to these for some discussion at this point, but my article is already too long. Perhaps it is enough to note the fact that, being incident as they are to intrinsic relations, self-existing in man, which undergo no complication and no change, the moral notions that define them may easily have been quite as distinct at some earlier stages of human culture as they are now. If they manifest themselves no more potently in conduct than they did twenty centuries ago—which seems doubtful, upon the whole—the fact must show us how little our modern civilization has yet advanced the race in moral discipline, whatever gains in moral knowledge it may have brought.

DOES IT TAKE TIME TO THINK?

(SOME MEASUREMENTS OF THE PERSONAL EQUATION.)

By T. F. BROWNELL.

MASKELYNE, the Royal Astronomer of England, in August, 1795, had his attention called to the fact that his assistant, Mr. Kinnebrook, was making errors in recording observations. He noticed that Mr. Kinnebrook had fallen into the habit of making his records half a second later than they should be. In the following year this fault was found to have increased. All of Mr. Kinnebrook's observations were recorded as about four-fifths of a second too late. The assistant was a trained and skilled observer of long experience, but, although the fault was pointed out to him, and realized by him, it appeared impossible for him to overcome it. The same error still appeared in all his work. The two astronomers, it must be remarked, were working together observing and noting the same events, such as the transits of the same stars across hair-lines placed in the fields of vision of their telescopes or transit-instruments. After observing side by side a large number of events, and recording the times as accurately as they could to the second and fraction of a second in each case, it was found by a comparison of results that the events were almost invariably recorded by Mr. Kin-

nebrook as having taken place four-fifths of a second later than the time observed and noted by Maskelyne. All attempts by Mr. Kinnebrook to account for or to remedy what he deemed his fault were in vain. At last Maskelyne, assuming that his own observations were correct, and that the habit of his assistant arose from some defect difficult to explain, felt obliged to discharge him as incompetent for the special class of work in which he had been long engaged. At the present day astronomers, with better knowledge of the degree to which the personal element enters into all work, and especially into a class of labor so difficult as that of recording fractions of a second or hundredths of an inch, are accustomed to place as much reliance upon the observations of Mr. Kinnebrook as upon those made by the royal astronomer himself. The constant difference in the result is explained, not by the assumption of incompetency on the part of one of these astronomers, and of complete accuracy on that of the other, but by reference to what is known as the relative personal equation of the two men. It is not supposed that the records made by either of them are absolutely correct. Beyond a doubt there is in the records of each a small and constant error arising from personal characteristics. There is no reason to suppose that the amount of this error was larger with Mr. Kinnebrook than with Maskelyne. The absolute personal equation, as the error is called, is as likely to appear in the observations of one as in those of the other. The error of four-fifths of a second, which invariably appeared, does not represent a difference from the exact truth, but the constant difference between the amount of error habitual to one of these observers and the amount of error habitual to the other. But, as we do not know the personal equation of either, in this, which is the first recorded case of the kind, we can never know where the truth actually was.

By this and similar cases the attention of scientific men was called to the effect of personal characteristics in classes of work similar to that of the astronomical observatory. Examination showed that these characteristics are a constant cause of error. By numerous experiments it appeared that one who observes and records an occurrence always gives a result which differs from the exact truth. Even where the observer was trained and skilled in observing events like those in the experiment, the rule was the same. He recorded the time too early or too late. The error would appear in each experiment, and always to the same amount. If the record was too late in one, it invariably was too late. This habitual difference between the time as noted by an observer and the actual time of the happening of the occurrence is what has been termed the absolute personal equation of that observer. It represents the amount of error which he will always make. It has been found to differ with different persons for the same class of events. It also differs in the same person for events of different classes. The time required to observe and

record the happening of a sudden and unexpected spark, for instance, is always greater than that required in the case of the expected appearance of a letter or figure thrown upon a screen. The equation also differs according as the facts are observed by the use of one of the senses or of another. The time required for some of the senses to convey intelligence to us is far greater than that required by others.

In making astronomical observations the equation requiring attention is that relating to the sense of sight. Being the value of an habitual error, it invalidates all observations, since the record of each observer is incorrect in a certain constant amount. It is, therefore, necessary to obtain the personal equation of the observer, and to add or subtract this from the results which he notes, in order to know the true time of the occurrence recorded by him. This can easily be done. To obtain the equation for observation of the transits of stars, for instance, the method is quite simple. A luminous point similar to a star is made to move with uniform velocity in a circle, and to pass across the field of a telescope. The exact time the point is upon the hair-line which divides the field of view is correctly recorded by mechanism which stops a chronometer. The observer watches the luminous point, and as soon as he sees it upon the line presses a button which stops a second chronometer. The difference between the times indicated by the two chronometers gives the personal equation of the observer for the transits of stars, recorded by pressing a button. Its amount will be very small. When the time is taken by glancing at a clock and then noting, the equation of almost all observers is so large as to demand a correction.

Since personal characteristics are the cause of a constant error, it follows that two observers of equal skill, using instruments of equal accuracy in observing and recording a large number of occurrences, will always differ from each other in the results obtained, and in an amount that will always be the same. This constant difference between the results given by two observers is called their relative personal equation. The four-fifths of a second between the records of Mr. Kinnebrook and Maskelyne was the value of such an equation. It is the sum or the difference of the amounts of error habitual to each. Its value may be found by experiment, or by adding together the absolute equations of each, or by subtracting one from the other in case the tendencies to error are in the same direction.

An interesting example of a personal equation was the ground of a serious criticism made about a year ago upon the trustworthiness of the observations made at Greenwich. In timing the class of observations which were criticised, the record was kept at the observatory in seconds and tenths of a second. The first record was made at the time of the observations by dots or punctures made in a tape running over a drum, the spaces between the dots representing cor-

responding lengths of time. The tape was prepared for use by being marked off by printed dots, about a third of an inch apart, into spaces representing seconds. The permanent record was prepared subsequently by reading off the results noted upon the tape. To read off the whole seconds was of course a simple matter of enumeration of spaces representing seconds. The fractions of a second, however, it was customary to estimate in tenths of a second. The estimation was made upon the position of one sharply-marked dot as referred to two other well-defined dots, one on each side of it, indicating the beginning and the end of a second, and separated about a third of an inch. It was done by inspection of the tape, by highly-trained and experienced men, to whom it had been a daily work for years. Such being the methods, an astronomer connected with another observatory selected at random from the reports of the Greenwich Observatory a large number of records, and caused the number of times each fraction of a second occurred to be counted. Theoretically, there is no reason why one fraction should appear more often than another. An examination of over 1,200 instances, however, showed that certain fractions appeared much more frequently than they theoretically should. The figure 4 or $\frac{4}{10}$, and the figure 0 or $\frac{0}{10}$, were found too often. Upon this fact was founded a criticism upon the accuracy of the reports. It was claimed that the frequency of these fractions was occasioned by personal characteristics in the person who estimated the fraction; and it was assumed that such were the idiosyncrasies of even the most highly-trained persons, that in making such estimations they would unconsciously tend to use certain figures rather than others; in this case it was argued that the tendency causing error was to make the record four-tenths for most fractions between three-tenths and five-tenths, and where the dot was near the end of a second to record the time as a whole second. This criticism was offered in a dignified and serious way in a prominent scientific journal, and was as earnestly replied to and discussed by the observers at Greenwich in the same journal.

This example of the personal equation is quite different from that which was first briefly described. The value of the equation in this case it is impossible for us to formulate with accuracy in the present state of our knowledge. In examples like the first, the factors can be more readily observed, analyzed, and measured. The difference which appeared in the case of Maskelyne and Mr. Kinnebrook arose, without doubt, from the fact that nervous and mental actions require time for their accomplishment, and because the rate of nervous transmission and mental action in one of these observers constantly differed from that in the other. The problem of the personal equation in this aspect becomes one of physiology and psychology. As such it has been investigated with great research by specialists during the past twenty years. And, although the results obtained are in most cases only

approximately true, the various experiments that have been made are not without some curious interest.

It is well known that the operations of the nervous system require time. The action of the different senses is not instantaneous; there is always an interval of time after a foreign body touches our skin before we know that it touches us. So also between the mental decision to make a movement and its actual execution there is a real though short interval.

Where upon sight of a star a button is to be pressed, there is, first, the action of the sense of sight which gives us knowledge of the existence of the star; and, second, action of the will causing pressure of the button. In fact, the physiological and psychical action, in all cases where excitation is followed by the giving of a signal, may be divided into six separate and successive actions. The sensation may be divided into three distinct acts. In the example supposed there is, first, the reception of the image of the star upon the retina; second, the transmission of the stimulus through the nerve from the eye to the brain; and, third, the mental perception of the existence of the star. The voluntary movement which causes the signal may also be divided into three acts. There is, first, the act of the will by which it is determined to press the button; second, the transmission of the impulse through the nerves from the brain to the hand; and, third, the excitement of the muscular fibres by which the finger is bent and the button pressed. The entire interval between the excitation and the giving of the signal, during which these six acts occur in succession, has been called the physiological time. It is really the same in amount, in most cases, with the personal equation. That portion of it which is occupied with the purely mental acts of perceiving the signal and determining the signal is called the psychical time. It is the time required to think.

Attempts have been made to measure each of these six factors, and interesting results have been obtained, though of various degrees of accuracy and trustworthiness.

The earliest experiments were made with reference to the rapidity of movement through the nerves. The first attempt to measure the velocity of nervous impulses proceeding from the brain under action of the will was made long ago by Haller. He ascertained, by reading aloud with great rapidity extracts from the "Æneid," the average number of letters which he could pronounce in one minute. Then he calculated the length of the nerve from the brain to the muscles of the tongue and mouth. Each letter he regarded as requiring a nervous impulse. He was obliged then only to multiply the number of letters spoken in each minute by the length of the nerve. This gave as a result that the rate of nervous transmission from the brain was about 150 feet a second. This experiment was defective in failing to take into account the facts that both the act of willing and that of

muscular contraction require time. Had these been considered, the solution would have been farther from the truth than it really was. Recent investigations of more precision have not, however, given results that differ widely from that obtained by Haller. The rate as given by Helmholtz, after many experiments, is about 111 feet per second. This is now generally accepted as the most accurate statement. Slight differences in results for movements from the brain, and for those proceeding to it, have been obtained in the investigations, but the rate is regarded by the best authorities as essentially the same for both movements. If there be a difference, it arises because the rate of voluntary impulses moving from the brain outward is the more rapid of the two.

A difference also has been found to exist in the rapidity with which we perceive impressions received through the eye, and those received through the ear. This at one time was supposed to be caused by a difference in the rate of transmission in the respective nerves. The better authority now is that the disparity is occasioned either by difference of length of the two nerves, or because the mind does not so readily distinguish impressions of one kind as those of the other.

If these data are correct, it requires at least one-twelfth of a second for us to perceive a sensation in our foot. A mosquito which selects our ankle as the field of his operations has nearly a sixth of a second in which to make his escape, for it requires at least one twelfth of a second for us to find out that the mosquito is there, and another twelfth of a second for us to make up our mind to declare war upon him and to initiate hostile action.

It will be observed that the rate of nervous transmission is comparatively slow. Electricity travels at the rate of many thousand miles a second, or, more accurately, 16,000,000 times as fast as nervous action. Light moves about two-thirds as fast as electricity. If we examine movements which are comparatively sluggish, we find that a cannon-ball, when fired, moves about 900 feet a second, or nearly ten times as fast as nervous energy. A railroad-train speeding along at sixty miles an hour would be moving at about the same rate as an ordinary nervous stimulus, though in a contest the stimulus would probably win.

By further experiment it has been determined that the time required for the excitation of the muscular fibres for such acts as the supposed pressing of the button, this being the factor last in order of the entire six, is about one-hundredth of a second.

It is also declared with some precision, both by analogy to this last act and by experiment, that the time required for the reception of the impression by the sensitive membrane, which is the first and a corresponding factor of the complete physiological time, is also about one-hundredth of a second.

There are now left undetermined only two of the factors. These are the time required for the two purely mental acts: first, of perceiving the sensation; and, second, of willing the movement which immediately follows. These two make up the psychical time. It may be obtained by first learning the entire physiological time, and then subtracting from that the value of the four known factors, the determination of which has been given. This would leave the period required for the purely mental operations of distinguishing and willing.

For the purpose of learning the physiological time for events of different orders, a large number of carefully-prepared experiments have been made by different investigators. Though the results arrived at lack much in accuracy and completeness, they are highly interesting and instructive.

For experiments relating to sight the arrangement is usually of the following nature: The patient is seated before a screen, upon which certain letters or numbers can be thrown, or before glass globes, which can be suddenly illumined by an electric spark. Upon seeing the number, letter, or illumination, as the case may be, the patient immediately gives a signal by some slight movement of the hand or foot. Nice arrangements are provided, by which both the event and the signal register themselves, giving the time exact to the thousandth of a second.

The general result of many experiments is, that the time required for ordinary persons to distinguish an appearance and to give the signal amounts to about one-fifth of a second. Exactly speaking, in the experiments of one scientist, the time required was found to be .188 of a second. In trials made by three other investigators the results have been .200, .205, and .194 of a second respectively. None of these conclusions varies much from one-fifth of a second. A comparison has also been made between cases where the event was an electric spark and others where the event was the passage of a luminous point across a line, the signal being the same in each experiment. According to one series of trials, it was found that the time required in the former case was .200 of a second and in the latter only .077 of a second. In other words, the perception and signaling of the former occupied three times as much time as in the case of the latter.

In experiments with the sense of hearing, the arrangements are generally of the same nature. The event is usually the sound of a bell or note, or of a spoken letter or number. For this sense the physiological time has been calculated to be about one-sixth of a second. Four investigators give .148, .1505, .180, and .182 of a second, as the exact results of their experiments. It will be noticed that the physiological time for the sense of hearing is shorter than for that of sight. We hear more quickly than we see.

For the sense of touch there is a discrepancy in the results thus far given by different investigators. According to the best authority, it appears that the physiological time in this case is about one-seventh of a second, and less than that of sight or hearing. Some, however, make it somewhat larger than this, and place it midway between those of sight and hearing.

Having thus found the entire physiological time by many carefully-prepared experiments, and having previously obtained, as has been briefly pointed out, the value of four of its factors, the value of the remaining two can be readily obtained by subtracting. We should then have the time necessarily employed in purely mental acts of distinguishing or recognizing an event and willing the signal.

One careful investigator, after experiments in which the event was the sounding of a bell, and the signal was made by pressing with the foot, tabulates the result with the following precision:

Time occupied (in seconds) by the mechanism of hearing the bell	.010
By the act of perception of the sound and of willing the signal	.112
By the transmission of nervous impulse through the spinal cord and nerve of the leg to the foot	.088
By the mechanism of muscular contraction in moving slightly the foot	.010
Total physiological time	.220

This is only slightly more than one-fifth of a second.

The two mental operations, it will be perceived, occupy somewhat more time than is required for the transmission of the impulse to the foot, and a little more than one-half of the entire time.

In all the tests thus far given the operation of the mind is as simple as possible. The terms of the problem are reduced to their lowest forms. Upon the simplest kind of a perception, and that expected, the patient is required to exercise his volition in the simplest way. There is no necessity of making comparison between two or more sensations, or of deciding between two or more courses of action.

But in the following experiment the mental acts required were more complex. The patient, upon receiving a slight shock given to the right foot, was to give the signal by moving the right hand, and upon receiving the shock in his left foot he was to give the signal with his left hand. He was left in ignorance upon which foot the shock was to come. It was found that under these circumstances the physiological time was prolonged one-fifteenth of a second beyond the corresponding time where the patient was informed which foot was to receive the shock. In the latter case there was no need of reflection, but in the former he was obliged first to decide which foot was touched, and then to decide upon the corresponding signal. One-fifteenth of a second represented the time required for these acts of the mind.

A similar test was made for the sense of sight. For a red light

the signal was to be given with the right hand, for a white light with the left hand. In this case the mental action of deciding these alternatives and coördinating the corresponding act of volition required no less than .154, or nearly one-seventh of a second.

Other experiments have been made with the sense of sight, where the patient was instructed to give the signal by pronouncing the name of a vowel which was shown to him. If he had to distinguish between two vowels, the psychical time was prolonged .166 of a second beyond what it would have been for one vowel. If he was required to name one out of five, the prolongation was increased to .170 of a second.

Similar experiments with the sense of hearing, where the vowel was spoken to the patient and repeated by him, gave similar results. Where two vowels were selected from the mind occupied .056, and where five were used .086 of a second longer than if only one expected vowel were spoken.

Where two colors were shown, and the signal was given by a movement of the hand, or by the voice, the physiological time for the movement of the hand was found to be always greater than for the voice.

When the signal was the pronouncing of a vowel, as "i," the time required was less than when the patient was obliged to speak the vowel with a consonant before it, as "pi," or "ki," or "ti." The letter "p" was found to retard the patient .011 of a second, "t" twice as long, or .022 of a second, and "k" .021 of a second. A further result of these curious investigations was that the patient required three times as long to distinguish between two letters which were shown upon a screen as to distinguish between the two corresponding vowels when spoken.

In all these investigations the psychical time is made up of two periods: the first required by the mind to perceive the sensation or to distinguish the alternative, the second required for the mental act of willing the signal. An attempt has been made to measure each of these. The experiment for this purpose was so arranged that the patient was to hear several vowels, but was directed to give the signal only upon hearing a certain one of them. Under this arrangement the patient concentrated his attention upon the perception of the vowel at hearing which he was to act. He prepared himself, as far as could be, to pronounce it the moment he heard it. Before he heard it he willed to speak it on the instant that he should perceive it. There remained only the act of recognizing the vowel when it should be spoken, of distinguishing it among the other vowels. The act of volition was in this way eliminated from the physiological time, and the simplest mental act of distinguishing was calculated from the result. This result, based upon this and similar experiments, was that the mental act of distinguishing required about one twenty-third of a second of time. The whole psychical time being about one-twelfth

of a second, the time required in ordinary cases for the remaining act of willing was easily calculated to be about one twenty-eighth of a second. If these investigations can be regarded as entirely trustworthy, they tend to show that the mind perceives somewhat more slowly than it wills.

Of the personal equation, in its widest sense, there are many examples even more suggestive and worthy of extended treatment than these which have received mathematical measurement. These examples are to be found in all human action, and in the result of all human work. Noticeably is this true in all acts and occupations which have their basis and lowest forms in acts of imitation. None the less is it true in those higher forms of art and action where close imitation is less desired than the interpretation of some pervading spirit, or the representation of some underlying essential. In the acts of painting a landscape, of copying a picture, of interpreting a symphony, of reading a poem, of acting a play, of following an argument, or in any of the common or artistic acts of men, be they mental or physical, the personal equation of the actor enters as a perceptible element in the result. The discussion of the nature and value of the personal equation where it appears in forms so subtile as in the cases last mentioned would furnish many considerations of interest and instruction, but to undertake the treatment of these forms is beyond our present purpose or opportunity.

ABORIGINAL POTTERY OF THE SALT-SPRINGS, ILLINOIS.

By GEORGE ESCOL SELLERS.

IN the work by the late J. W. Foster, LL. D., on the "Prehistoric Races of the United States of America," published in 1873, when treating of the pottery of the mound-builders, on page 248, he says:

"On the Saline River, Gallatin County, Illinois, according to MS. notes of Prof. Cox, there is, just above low-water mark, a salt-spring, which was resorted to in the earliest settlement of the country, by those of European descent, for the purpose of procuring salt by evaporating the brine. Here occur, however, numerous fragments of pottery, showing that a prehistoric people had resorted to the same spring, and for the same purpose. From the slight curvature of the fragments it is evident that the vessels were of large capacity. The material is coarse, and the general thickness of the vessel is about half an inch, but at the rim it is three-quarters of an inch. The exterior is marked by vertical lines of depression about half an inch apart, with bars less conspicuous and close together, sometimes at right angles, and at others oblique. When I first saw these specimens, I was somewhat surprised that the makers should bestow so much ornamentation on vessels so coarsely made, and applied to such ordinary uses;

but a slight examination showed me that these figures had been impressed and not carved; *or, in other words, that a basket of rushes or willows had first been constructed, inside of which the clay was moulded and allowed to dry before burning.*"

Then, in a foot-note, he continues:

"Since this chapter was written, I have seen a paper of Mr. Charles Rau, of New York, on the aboriginal pottery of this country, in which he refers to this locality, and arrives at the same conclusion as myself. . . . I had occasion to examine a fragment of a vessel sent to Dr. Davis in 1859, by Mr. George E. Sellers, who obtained it at the salt-springs, near the Saline River. . . . Several acres, Mr. Sellers states, are covered with broken vessels, and heaps of clay and shells, which indicate that they were made on the spot. They present the shape of semi-globular bowls with projecting rims, and measure from thirty inches to four feet across the rim; the thickness varies from a half to three-quarters of an inch.

"The earthenware has *evidently been moulded in baskets.* It is solid and heavy, *and must have been tolerably well baked.* The impressions on the outside are very regular, and are really ornamental, proving that these aboriginal potters were also *skillful basket-makers.*

"Mr. Rau quotes from Hunter, as to the aboriginal mode of making pottery, 'Another method practised is to coat the *inner surface of baskets, made of rushes* or *willows*, with clay, to the required thickness, and, when dried, to *burn them* as above described.'"

My object in writing this article is to refute a theory that would attribute to the rude, prehistoric people of the Stone age a skill in manipulation that cannot now be approached by the skilled artisan of the present age; that is, keeping in form and lining with heavy clay fragile baskets of the large size of these old salt-kettles.

About the time I sent the specimens to Dr. Davis referred to by Mr. Rau, I also sent some to the Hon. Thomas Ewbank, and in my letter accompanying I stated that I had discovered what at first I took to be an entire kettle bottom-up; but, on removing the earth that covered it, it appeared to be a solid mass of sun-dried clay. From its position among heaps of clay and shells, its hard, compact, discolored —I might say almost polished—surface, I became satisfied it was a mould on which the clay kettles had been formed, precisely as in loam-moulding at the present day.

Mr. Ewbank, in reply, said he thought I was mistaken; that what I took for a mould was most probably a concreted sediment that had filled a kettle and been turned out; that there was no evidence of the aborigines of either North or South America having ever used the lathe, or formed their ware by striking; not even among the Peruvians, whom he considered far in advance as to forms and quality of pottery-ware. They had moulded bottles or jugs on *gourds*, and open vessels in *baskets*, which had been burned out or off in baking; he thought the specimens I sent him bore evident marks of reed baskets, etc.

Before presenting the facts that have confirmed me in my original view of the manner in which these salt-pans were formed, and that I may be better understood, I will endeavor to describe the location where the fragments are found.

My first visit was in company with my friend the late Dr. David Dale Owen, about the year 1854. We found two water-worn ravines, commencing on the hills that rise abruptly on the south side of the Saline River, and drain into it. At the base of the hills they are crossed by a State road, between which and the river their bottoms are level, hard, and barren, and here, close to the road rise the salt-springs. Between the ravines is a bench or river-bottom subject to annual overflow.

These bottoms, as well as the hill-sides, were covered with a thick growth of young timber—the primitive forest having been cut off for fuel for evaporating the brine at the time the salines were worked by the early settlers. The principal spring was then, and is now, known as the "Nigger" well or salt-works, as it was worked by slave-labor while the State of Illinois was a Territory.

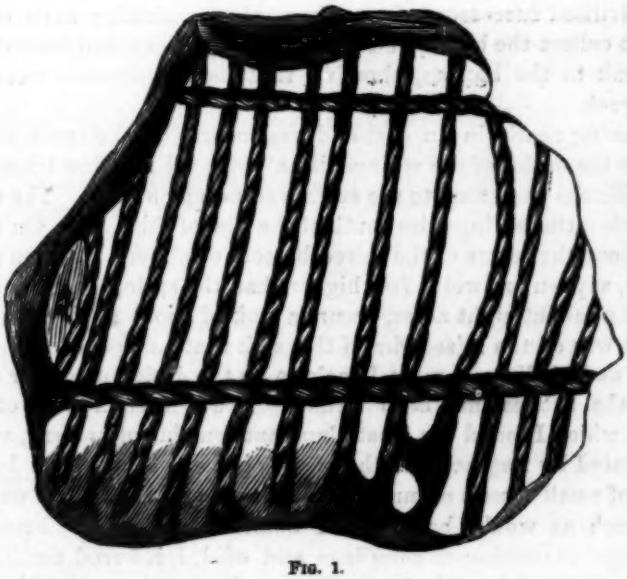

Fig. 1.

The spring in the west ravine overflowed a curbed well about eight feet square, which I sounded, and found to be about forty feet deep. In the east ravine a salt-spring was oozing. A short distance above the curbed well flows a sulphur-spring, and near it one of good fresh water.

I have been informed, by a reliable party who had personal knowledge of all that was done by the early settlers in working the salines,

that in the east ravine they sunk a well and curbed it down to the bed-rock, a depth of 42 feet, and made a boring of about 150 feet in its bottom. That all the way from the surface to the rock they found pieces of broken pottery, and on the rock a pitcher or jug, with a handle within the rim; this jug was sent to the Philadelphia Museum. My informant expressed the opinion that, at the time the aborigines used the waters, the spring had its outlet at or near the bed-rock, and had since gradually filled by surface-washings, just as the well in the west ravine has been filled since my first visit, and is now a cattle-tramped salt-swamp.

The present outlet of the spring is not over six or eight feet above low water of the Saline River, and the character of its bed precludes the possibility of its ever having been on a lower level; for at Island Ripple, within two miles of the spring, the river falls over a broad reef of rocks which backs the water—forming a pool—up to this place, where there is another slight ripple.

This, to me, is conclusive evidence that, whoever the people were who left the masses of broken pottery as proof of their having used the salt-waters, they resorted to precisely the same means as did their more civilized successors of our time—that is, sinking wells or reservoirs to collect the brine; and the dipper-jug which had been dropped had sunk to the bottom, showing that their reservoirs were down to the rock.

Running nearly in an east-and-west course on the south side, and close to the outlet of the springs, is an upheaval that has brought the carboniferous limestone to the surface standing on edge. The sulphur and fresh-water springs rise south of the line of this dike. On the line of it, about the centre of the raised bottom or plateau between the two ravines, say ten or twelve feet higher than the springs, and embracing an area of about eight acres, occurs a sink of about 120 feet in diameter. It was on the raised rim of this sink that I discovered the heaps of clay and shells, and what I took to be the inside mould or core on which the kettles had been formed. It was then a pool of water, around which I found the most abundant remains of pottery, not only represented by fragments of the large, coarse salt-pans, but by many pieces of small vessels of much finer texture, and of superior workmanship, such as would be used for domestic purposes. From these and large quantities of chippings and offal, I inferred that this was the site of the old settlement. The broken pottery, the black soil, the waste from long occupancy extending a considerable distance both east and west of the springs, and to the foot of the bluffs on the south, covering an area of about thirty acres, were confirmatory of this view; but the fact of the annual overflow made me look further for a permanent settlement.

The hills at this point run nearly an east-and-west course, forming a range of upheaval that crosses the State of Illinois, from the

Ohio River at Shawneetown to the Mississippi, and at some places attains a height of about 700 feet, being the highest land in Illinois or in either of the adjoining States of Missouri, Kentucky, and Indiana. Immediately south of the salt-springs is a spur of the main hill, its northern terminus being precipitous bluffs of metamorphic sandstone, which Prof. Worthen, the State Geologist of Illinois, who once visited the location with me, classed with the Chester group. Above this bluff, where the spur rises at an angle of about 30°, it has been terraced, and the terraces as well as the crown of the spur have been used as a cemetery: portions of the terraces are still perfect; all the burials appear to have been made in rude stone cists, that vary in size from eighteen inches by three feet, to two feet by four feet, and from eighteen inches to two feet deep. They are made of thin-bedded sandstone slabs, generally roughly shaped, but some of them have been edged and squared with considerable care, particularly the covering-slabs. The slope below the terraces was thickly strewed with these slabs, washed out as the terraces have worn away, and which have since been carried off for door-steps and hearthstones.

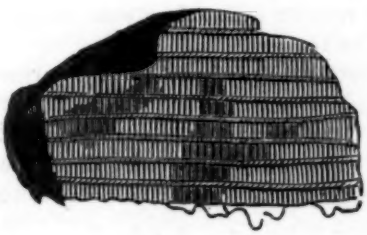

FIG. 2.

I have opened many of these cists; they nearly all contain fragments of human bones far gone in decay, but I have never succeeded in securing a perfect skull; even the clay vessels that were interred with the dead have disintegrated, the portions remaining being almost as soft and fragile as the bones.

Some of the cists that I explored were paved with valves of fresh-water shells, but most generally with the fragments of the great salt-pans, which, in every case, are so far gone in decay as to have lost the outside markings. This seems conclusively to couple the tenants of these ancient graves with the makers and the users of the salt-pans.

The great number of graves and the quantity of slabs that have been washed out prove either a dense population or a long occupancy, or both.

On the crown of the main hill above the cemetery are ranges of circular depressions, from one to three feet deep, and from fifteen to twenty-five feet in diameter; they cover a large area, on two sides of which there is evidence of earthworks.

I had the soil removed from one of these depressions, and found marks of long-continued fire in its centre, from which I infer that they are sites of the lodges of these ancient people.

The general character of this portion of the hill-range is precipitous to the north, with a very gradual descent to the south, forming the north slope of the broad and beautiful valley of Eagle Creek, a tributary of the Saline, a valley once cultivated by the prehistoric people that worked the salines, evidenced by the fine specimens of stone agricultural implements turned up by the plough, and most abundant near the earthworks.

I have in my collection, from this locality, four hoes or spades, flaked out of chert or quartzite, most probably from the metamorphic sandstone of the district. They are beautifully wrought, and vary in size from six and a half by three and a half to ten and a half by four and three-quarter inches, and from one-half to three-quarters of an inch in thickness.

On receipt of Mr. Ewbank's letter in 1859, I examined carefully quantities of specimens of pottery, and found the markings on all of them to have been made by *woven cloth* of *twisted threads*, and in no single instance by rush or willow baskets. Some of these cloth impressions were of fine texture.

When I considered that a basket of the large size of these salt-kettles, even if made of metallic wire no thicker than the thread impressions, could not possibly be kept in form while being lined with heavy clay, the idea of using any twisted textile fabric for such a purpose seemed absurd. We must, therefore, look for some other explanation of these markings.

They could not be for ornament, or the rough, sharp edge of the projecting rim would have been finished with more care, or where threads had broken, or pieces been torn from the cloth, the defects in the markings would have been repaired.

Some of the threads of the cloth being at right angles to the rim, and gradually becoming oblique or bias, presented the exact appearance which a bandage of cloth would, if tightly bound round a semi-globular bowl.

I imagine these half-civilized people to have been practical utilitarians; and I can see the use of a bandage in holding the moist clay firmly bound while being raised from the mould on which it was formed, and which was essential to prevent cracking as it hardened or dried.

If a bandage was used in this manner and for this purpose, there could probably be found pieces of the pans showing the width of bandage used, also where and how it had been fastened at its union.

Therefore, my first object was to secure all the specimens that I could, also the mould or core on which I believed the pans had been formed. But from the time I collected the specimens sent to Mr. Ewbank and Dr. Davis, it was nine or ten years before I again had an

opportunity of visiting the springs. I then found the plateau between them cleared and under cultivation; the water had dried from the sink; a crop of corn was growing on its bottom; the plough had overturned and broken the mould, but in doing so had exposed portions of others of the same character. They appeared to have been small mounds built of stone, and covered with a tenacious yellow clay, which, by sun-drying, had become as hard as common salmon-brick.

From the position of the moulds on the rim of the sink, I inclined to the opinion that it was mainly an artificial reservoir for water, and the centre of a great pottery-manufactory; the material used being the siliceous fire-clays and shales of the coal-measures, which are found in abundance, decomposed and ready for use, in ravines within reasonable distance of the locality, together with fresh-water shells from the reefs and ripples of the Saline and Wabash Rivers, using bivalves and univalves indiscriminately.

The plough had played sad havoc with the pieces of pottery I expected to secure. At first, pieces ten or twelve inches across were easily obtained; now one as large as the hand is a treasure: this breaking up made it very difficult to secure the evidence I was looking for. I made many thorough searches before finding any specimens of well-marked unions of the bandages, or establishing conclusively that in no case were the bottoms of the large vessels marked, as they would have been if formed in baskets.

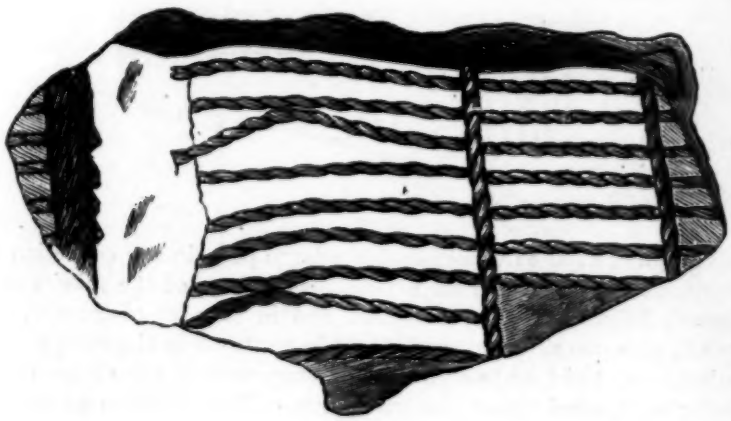

Fig. 3.

A person familiar with the work of the early settlers informs me that, in grading for foundations of their salt-furnaces, several of the large pans, almost perfect, were unearthed and destroyed by the black laborers. He paid no attention to the markings, only observing that their bottoms were perfectly plain, and described them as "basins, as large around as the hind-wheel of his wagon, with flattish bottoms."

At the present salt-works, about five miles higher up the Saline River, on its south fork, near Equality, is the "Half-Moon Lick," where the earth has been licked away to a depth varying from twelve to sixteen feet, in the shape of a horseshoe, about 200 yards from point to point of the heels, and to the toe, or back of the curve, 250 yards. In this lick are still to be seen deeply-trodden buffalo-roads. On one bank is a slightly-raised ridge, in which were found imbedded a number of earthen vessels in a row. Mr. B. Temple, one of the proprietors of the salt-works, described them to me as between four and five feet diameter and sixteen to eighteen inches deep. After uncovering, they were not removed, but suffered to go to decay. The bones of the mastodon have been found here.[1]

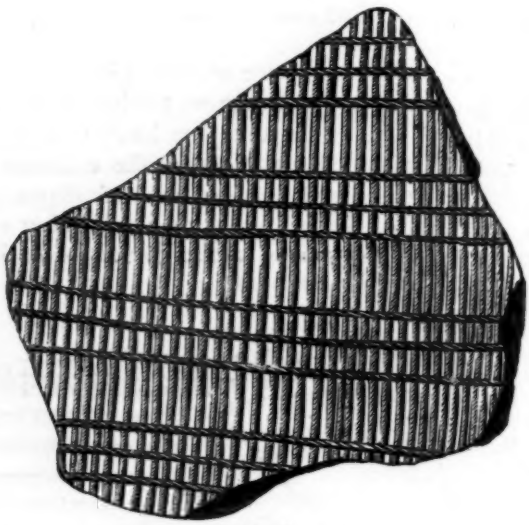

Fig. 4.

On many of the fragments of the large pans in my collection the impressions of the cloth are perfect delineations of the fabrics used. Though differing greatly in pattern and in fineness of texture, they are all, with one single exception, made or woven in the same manner —that is, by twisting two threads of warp around the single thread of the woof, precisely as the wire faces of laid moulds for forming paper are now made. The coarsest fabric that I find the impression of has warps about one and a half inch apart, with about five threads of woof to the inch. This piece is shown full size in Fig. 1; the double

[1] After writing the above description of the "Half-Moon Lick," I referred to Prof. E. T. Cox's report of it in the "Geological Survey of Gallatin County," as published in the sixth volume of A. H. Worthen's "Report" of Illinois, and find that he has probably trusted to eye-measurement, and greatly understated the extent of this remarkable lick.

I wrote to Mr. B. Temple, who confirmed what I had written, and furnished the actual measures, as given above.

warp when twisted being about one-eighth of an inch, and the woof from one-twelfth to one-tenth of an inch in diameter. It will be observed that the twist of the warp is continuous, while that of the woof terminates at, or is lost in, the warp.

The finest specimen I have has ten threads of warp to the inch, with a woof or filling of from thirty to thirty-four. Fig. 2 is a portion of it, showing the texture, which, though exceedingly close in the filling, is plainly impressed on the clay, even showing the twist of the threads and the crimping of the cloth as bound round the vessel.

The exception referred to is a square-mesh net. The squares are one-fourth of an inch; the threads in thickness about equal to No. 6 sewing-cotton; and the knots at the corners of the meshes are very distinctly marked.

Fig. 3 represents the first piece that I found giving any idea of the union of the bandage, which in this case appears to have been by the intervention of a stick to which the threads were fastened.

Fig. 4 is a piece of the rim of a vessel where the bandage has been united by twisting.

Fig. 5 is a similar piece, showing where two pieces of cloth of different texture have been united, and the obliquity of the threads to the rim caused by the hemispherical form of the vessel.

Fig. 6 shows varieties in the pattern of the cloth.

On none of the specimens do I find impressions of cloth woven as delineated by Mr. Foster (p. 225), as cloth from the mounds of Butler and Jackson Counties, Ohio.

Most of the fragments of the large vessels are of a leaden-clay color, and, where reddened by heat, it is more on the inside than on the outside. Some specimens that I found in the woods showed signs of the action of fire on the portions projecting above the ground, from the frequent burning of the woods. Where reddened by heat, most of the markings have been thrown off.

This and other considerations lead me to doubt a burning or baking process ever having been applied to them, and I do not think it would have been possible in open fires. The unequal heat would have caused unequal expansion and contraction, and consequent cracking.

It is evident that they are composed of a cement of siliceous clay and slightly-calcined shells. None of the pieces will stand a high heat and afterward moisture. I have heated to redness large pieces, that, on fracturing, I found to contain portions of coarsely-pounded shells (flakes as large as one-fourth of an inch frequently occurring). On cooling, they were about the color of common salmon-brick; when moistened, they at once fall to pieces by the slacking of the shell-lime; and when exposed to the air they gradually waste away, the lime only slacking and causing disintegration as it absorbs moisture from the air.

If formed of cement, they must have time to harden, and for that purpose must be removed from the mould on which they were formed, to prevent cracking by contraction; and here the cloth bandage becomes a necessity. But this cloth is a costly article, requiring a great expenditure of hand-labor and time. It must not be allowed to fasten

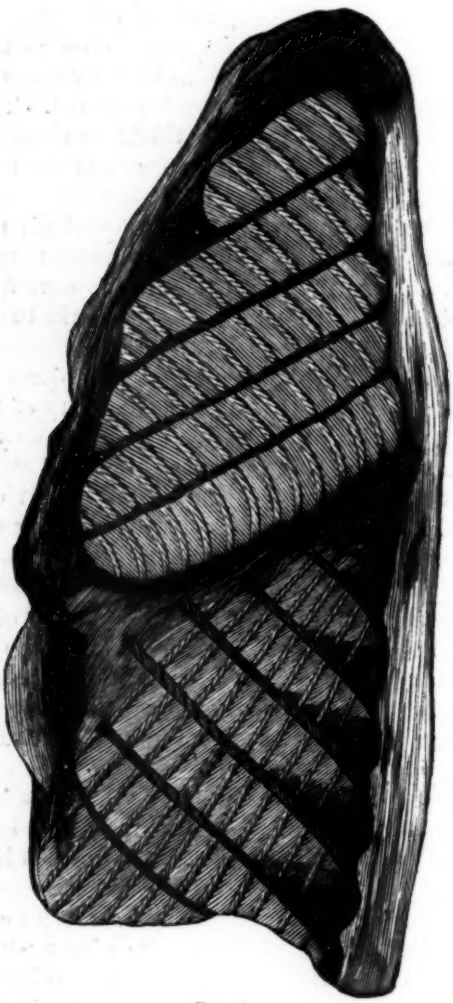

Fig. 5.

to the vessel as the cement hardens. To prevent this, a simple, natural device has been adopted. The pottery shows a laminated texture. No doubt every fresh layer of the cement has been hardly compressed on the previous one; for at hand we find the primitive tools that were used for the purpose, scattered over the site of this ancient pottery-

manufactory, in shape of flat river-pebbles, all of which are polished on the flat surface, just as the digging edges of the stone spades are by use. Cement thus compressed would be too hard to take the perfect impression of the cloth bandage; but a thin layer, or even a

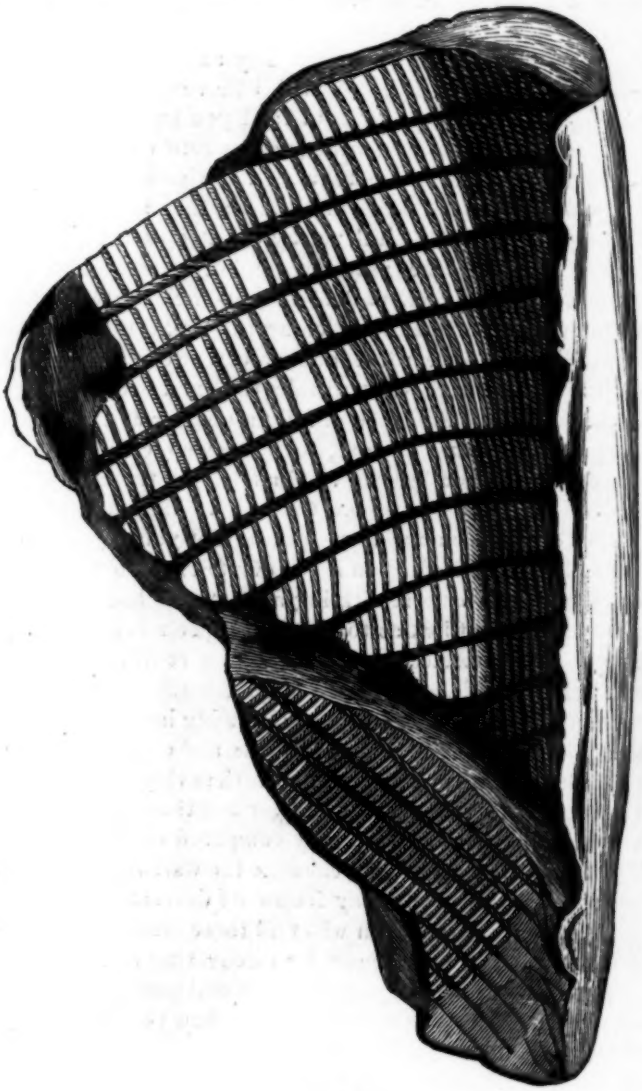

Fig. 6.

wash, of river-silt or mud would take it, and at the same time prevent the cloth adhering to the vessel; and, when required to be removed, a slight surface-moistening would accomplish the object without in-

jury to the cloth. The river-silt is sufficiently siliceous when in contact with a body of lime-cement, in process of time, to become almost as hard as the cement itself. I have succeeded in separating perfect sections of this thin surface-lamina from the underlying mass; but in no instance have I found this coating on the plain bottoms of the vessels.

And now, reader, if you have patiently and attentively followed me through these ramblings, and still believe this ancient, simple, practical people went the roundabout road you have been led to suppose to accomplish an object, with great waste of time, labor, and material, when a simpler, more natural, and direct way was open to them, and which my researches convince me they adopted, I will ask you to accompany me up the hill, not by the steep ascent, through the cemetery, but up the ravine, past the sulphur-spring. You will find it gradual and easy: in fact, part of the old, well-beaten foot-trail is now a wagon-road; but, before reaching the top, the trail leaves the road and winds among the rocks, one branch sweeping off to the left to the ancient settlement. We will take the one to the right. When you near the top of the hill, though fully a quarter of a mile from the salt-spring, keep a sharp lookout, for you may chance on a good specimen of well-marked pottery. On reaching the crown, you will be some distance west of the old town-site. Here the plough has been working destruction for many years; but you cannot take up a handful of soil without finding in it the *débris* of the old salt-pans.

You are now in a lane separating a young apple-orchard, thickly grown with clover (so thick as to cover all specimens), from freshly-ploughed cornfields, stretching far off to the south, over the grand valley of Eagle Creek.

If you can take your eyes from the charming landscape, climb with me the snake-fence into these ploughed fields, and examine the soil: you will not be likely to find any specimens worth saving, unless it be in an old fence-row, for the ploughshare has ground them and the corn has fed on them. Still, the soil is largely composed of disintegrated pottery. You may walk the furrows, examine the washes, the entire slope, to the east, to the west—you may follow its descent to the south—in every ravine, drain, or wash, you will find these remains, and you may possibly be repaid for your tramp by discovering among the wasted pottery and flakes of chert a spade, a rough and peculiarly-chipped arrow-point, or a flaked axe or chisel. But when your legs have given out, and you can walk no farther, you will have failed to find the boundaries that limit the district over which these remains are strewed. Then you will sit down and ponder in amazement, and ask, "What object could these people have had in carrying their broken pans and strewing them broadcast over so vast an extent of country, and so far from the salt-springs?" As you sit thinking, you feel the warmth of the setting sun. Its rays cast your lengthening shadow on the hill,

and that of the hill far over the valley of the Saline; from these shadows you obstruct the rays of light, and from these glimmering rays you begin to realize that these simple people, who had advanced so far as to have learned the use and value of salt, probably from the herds of mighty animals that came to lap the water of the springs, or to lick the salt-impregnated earth, had also learned that the sun dried away the water and left the salt; and as they could not take the sun down into the valley to the water, they carried the water to the sun; and here on this southern slope, which then, as it does now, caught the first rays in early morning, its noonday beams, and evening kiss, were ranged scores—probably hundreds—of these primitive vessels, in which the sun, by its direct rays and heat-laden, southern breath, was doing the work of evaporation, yet not unaided by man. Around in every direction you find evidence of this, for every stone—and there are myriads—has been through the fire. They have been heated to redness and plunged into the brine.

Now, you may say I am indulging my imagination. Well, be it so. If I am, my imagination keeps within the bounds of possibility; while yours would endow these primitive people, whose only implements or tools seem to have belonged to the rude age of stone, with a skill in handling them far beyond what we in this enlightened age possess, with all our appliances. And you do this to give a color of truth to an entirely imaginary process, not sustained by a single fact.

INSTINCT AND INTELLIGENCE.[1]

By W. K. BROOKS.

TO many persons the phenomena of instinct and intelligence in animals seem irreconcilable with any theory of the evolution of organisms through the action of natural causes, but the popular opinion upon this subject has undergone a very considerable change within the last half-century, so that the difficulty now presents itself and finds expression in a much more manageable form than would have been the case a few years since.

With regard to instinct, we can easily see that if animals of a given species are born with a constitutional tendency, or instinct, to perform a certain action under certain circumstances, this tendency may be improved and perfected by natural selection, provided favorable variations appear, and be inherited. If instinct varies in the different individuals of a species, the struggle for existence will result

[1] A lecture from a course on "Biological Theories," delivered at the Johns Hopkins University, January, 1877.

in the destruction of those in which it is imperfectly or abnormally developed, and the preservation of those individuals which exhibit any advantageous variation.

In order to place the phenomena of instinct upon the same footing, with reference to natural selection, as is held by other manifestations of life, it is only necessary to show that instincts vary, and that these variations may become hereditary.

Not a great many years ago the statement that instinct varies among animals of the same species would have been met by a flat denial, but no one at all acquainted with the subject would probably now be found to dispute it. A few examples may not be out of place, however.

The oriole now builds its hanging-nest with the pieces of string, horse-hair, yarn, and carpet-ravelings, which are to be found in abundance about houses and barns; and I have seen a nest into which three fish-lines, with their hooks and sinkers, several yards of kite-tail from a telegraph wire, and a shoe-string, were interwoven. Of course, it is not natural for the bird to use such material as this, but the odds and ends furnished by man are much better fitted to its needs than the grass and fibres used by its less civilized ancestors. This change certainly shows power to improve in accordance with changed conditions; but it may perhaps be said that it is not an example of change in an instinct, but simply in a non-hereditary habit. The fear of man, shown by almost all the smaller animals, is in many cases newly acquired, for in regions uninhabited by man it is not shown, and it is only as the animals of such regions learn, by generations of persecution, that man is highly and peculiarly dangerous, that they come to avoid him; yet this fear is truly instinctive, for it is shown by the young as well as by the adult. The testimony of travelers as to the tameness of animals in regions where they have never been persecuted, is well known. For instance, Darwin, in his "Journal" of the voyage of the Beagle, says: "This disposition is common to all the terrestrial species of the Galapagos Islands, namely, to the mocking-thrush, the finches, wrens, tyrant fly-catchers, the dove, and carrion-buzzard. All of them often approached sufficiently near to be killed with a switch, and sometimes, as I myself tried, with a cap or hat. A gun here is almost superfluous, for with the muzzle I pushed a hawk off the branch of a tree. One day, while lying down, a mocking-thrush alighted on the edge of a pitcher made of the shell of a tortoise, which I held in my hand, and began very quietly to sip the water; it allowed me to lift it from the ground, while seated on the vessel. I often tried and very nearly succeeded in catching these birds by their legs. Formerly these birds appear to have been even tamer than at present. Cowley (in the year 1684) says that 'the turtle-doves were so tame that they would often alight upon our hats and arms, so that we could take them alive, they not fearing man until

such time as some of our company did fire upon them, whereby they were rendered more shy.' Dampier also, in the same year, says that a man in a morning's walk might kill six or seven dozen of these doves. At present, although certainly very tame, they do not alight upon people's hats, nor do they suffer themselves to be killed in such large numbers. It is surprising that they have not become wilder; for these islands, during the last hundred and fifty years, have been much visited by buccaneers and whalers; and the sailors, wandering through the woods in search of tortoises, take a cruel delight in knocking down the little birds."

Darwin also says that at Terra del Fuego a certain species of goose, which is much hunted by the natives, is so wild that it is a very difficult matter to kill even one, although in the Falkland Islands, where it is not often disturbed by man, a sportsman may sometimes kill more in a day than he can carry home. This goose is not migratory; but a bird of passage, the black-necked swan, brings with it to the Falkland Islands the wisdom learned in more dangerous regions, and is very hard to obtain. Darwin ends with the following comments: "From these several facts we may, I think, conclude, first, that the wildness of birds with regard to man is a particular instinct directed against him, and not dependent on any general degree of caution arising from other sources of danger; secondly, that it is not acquired by individual birds in a short time, even when much persecuted, but in the course of successive generations it becomes hereditary. With domesticated animals we are accustomed to see new mental habits or instincts acquired, and rendered hereditary; but with animals in a state of nature it must always be most difficult to discover instances of acquired hereditary knowledge. In regard to the wildness of birds there is no way of accounting for it except as an inherited habit; comparatively few young birds, in any year, have been injured by man in England, yet all, even nestlings, are afraid of him; many individuals, on the other hand, both at the Galapagos and at the Falklands, have been pursued and injured by man, but yet have not learned a salutary fear of him." If instincts have been acquired gradually by natural selection—like modifications of structure—we should expect to find that, like other adaptations, they are in many cases more or less imperfect. We were formerly taught that instinct differs from intelligence inasmuch as it is an infallible guide and perfect in its results. If we have shown that it admits of improvement, we need not argue its imperfection; but a few examples of the failure of instinct may not be out of place. Migratory birds often return too early in the season, and perish from lack of food. The instinct which leads insects to lay their eggs upon or near food which is proper for the larvæ to which the eggs will in time give rise, although the adult insect may feed upon something quite different, is a very wonderful and beautiful

provision of Nature, but it has been shown to fail signally in some cases. Certain flies lay their eggs upon decaying animal matter, in order that the maggots may find an abundant supply of proper food; but the flies are sometimes misled by the odor of a species of arum, and lay their eggs upon the leaves of the plant. The young, of course, perish as soon as they are hatched, for they are unable to subsist upon vegetable food. The presence of a certain odor stands in relation to the existence of putrid flesh, and there is in the fly a corresponding relation between the sensation caused by this odor and a tendency to deposit her eggs. That is, the relation between a certain sensation and a certain action is in harmony with another relation between two phenomena, external to the fly; but this adjustment is not quite perfect, since the odor of the arum-plant, which is not the right odor, does what nothing but the odor of putrid meat should do.

The trap-door spider makes for its dwelling a round hole in the ground, which it lines with silk and covers with a lid or trap-door, fastened with a hinge and lying even with the ground, and fitting so exactly that it is no easy matter to find the hole, even when the animal has just been seen to enter it. To render the deception still more perfect, the top of the door is sometimes covered with living mosses and lichens, which the spider is supposed to plant in this place; the whole apparatus is very wonderfully made, and we can hardly admire sufficiently the instinct which enables the animal to construct it. This instinct may lead to a great mistake, for a close observer of the habits of this animal—J. T. Moggidge—found a nest in sandy soil, where there was no vegetation. The lid had its usual cover of moss, although this failed to answer its purpose, for the little round spot of verdure made the nest very conspicuous instead of helping to hide it. The process of fish-culture furnishes a good illustration of the imperfection of such highly-important instincts as those concerned with the perpetuation of the species. It is found that if trout, white-fish, shad, or many other species, are allowed to lay their eggs in the natural manner, a very great proportion—usually much more than half—fail to be fertilized, and of the remainder many are destroyed by crowding and lack of fresh water; many more are buried by sediment, or carried away by the current, so that only a very few develop and give rise to young fish; and many of the young are so weakened by the unfavorable conditions to which they have been exposed that they are unable to free themselves from the remains of the egg-shell, so that the number hatched is very small indeed as compared with the number of eggs. To obviate this, the male and female fish are caught just before the time at which the eggs are deposited. These are pressed out of the body of the mother, artificially fertilized, and placed in proper hatching-boxes, and in this way the number of young is increased many hundred per cent. It is no exaggeration to say that, as compared with the artificial, the natural method of propagation among

these fishes is crude and faulty in the greatest degree. Nor can it be said that this wastefulness is compensated by the great number of eggs, for the production of so many eggs by the mother involves a great expenditure of force, which might be saved by more highly-developed instincts.

In view of all the instances given, I think we may conclude that instinct is not a fixed, immutable, perfect law and guide, but an imperfect, improvable, gradually-acquired method of adjusting actions to the surrounding conditions; and therefore subject to slow perfection through the survival of the fittest variations. Let us now see whether animals possess other mental powers than the instinctive; whether they exhibit any faculty which may properly be called intelligence. No one doubts that most of our domestic animals admit of individual improvement or education, but it may be said that this improvement is due to man's intelligence, not to that of the animals themselves. There is abundant proof, however, that animals are capable of much individual improvement in a state of nature. You can't catch old birds with chaff; and a new trap partakes of the properties of a new broom. Morgan, in his book on "The American Beaver and his Works," says that beaver-houses are often found of a construction very inferior to the average; and that, according to the Indians, these are the work of young animals which have not yet completed their education. Every one who has studied the habits of cats knows how frequently they fail to raise their first litter of kittens, and a very careful observer tells me that this is true of white mice to a much greater degree.

Leroy, a writer of the seventeenth century, and a very reliable authority, says that there is a marked inferiority in the nests made by young birds, and that the best and most complicated nests are made by those species of birds whose young remain a long time in the nest, and thus have more opportunity to see how it is made.

He says that not only are the nests of young birds badly made, but that very unfit places are chosen for them, and that these defects are remedied in time when the builders have been instructed by their sense of the inconvenience they have endured. Wilson likewise claimed that there is a very perceptible inferiority in the nests of young birds. To one at all familiar with animals, the fact that each individual undergoes a process of intellectual development and self-education is so familiar that it seems strange that any one should question it; but, as the contrary statement is still occasionally met with, it seemed proper to give the above instances of improvement.

The fact that dogs dream, and under circumstances of peculiar hardship and misfortune become crazy, seems to indicate a very close similarity between their minds and ours; and no one who has seen an idiotic or half-witted dog can doubt that an ordinary dog has a mind to lose.

Dr. Kane tells us that one of the Newfoundland dogs which spent two arctic winters with him was so oppressed by the darkness and solitude of the long night, and so reduced in strength by hardship and cold, that it at last became insane, and manifested all the symptoms which were observed in some of the human beings of the party who were affected in the same way by the same causes.

Many animals, poultry for instance, have special cries for special purposes: an alarm-cry to indicate danger; a call to announce the discovery of a supply of food; a maternal "cluck" to keep the brood of chicks together; and several other cries, each of which has a meaning. These cries are undoubtedly produced and understood by the fowls instinctively, but the process by which man learns to recognize them and to understand their meaning is purely intellectual. The farmer's dog learns to distinguish and understand them as well as the farmer himself, and knows when he may be unconcerned, and when he is to go to their defense; and there is not the slightest reason to doubt that he acquires his knowledge, as man does, by a process of observation, memory, and thought. Instances of intelligence among the higher mammalia could, of course, be indefinitely multiplied, but it does not seem necessary to dwell upon the subject here. I will, however, give a few examples of what seems to be intelligence among the lower animals. I think it was Lubbock who observed a spider which wished to raise a captured wasp to a more elevated portion of the web. Finding it too heavy, it stopped its efforts and gnawed off two of the wings, and then made a second attempt. As it was still too heavy, it lightened it still further, and again tested it, and repeated the process until it had reduced its load to a manageable size. I am unable to give the authority for the following, but think the account was published in *Nature* some years since: A gentleman found a small dead bird and impaled it upon a stick, and stuck the other end of the stick into the ground near some "scavenger" beetles. The instinct which leads these insects to bury dead birds and other animals as a provision for the wants of their young is well known. In this case they soon found the bird—but how was a bird perched upon an upright stick to be buried in the ground? After some consultation they resorted to the very clever expedient of digging up the stick, and then digging a hole large enough to bury both bird and stick. Although this seems very like intelligence, it may possibly be explained as a case in which the ordinary instinctive habit of the animal accidentally fitted an exceptional demand upon it.

Many of the actions of ants, however, do not admit of any such interpretation. When two armies of ants of different species leave their homes at the same time, arrange themselves in ranks, and march to a point of meeting, and engage in battle, they exhibit, not simply proofs of concerted action, but evidences that they can arrange and plan to meet extraordinary and unusual emergencies.

Of the actions which organisms perform in order to accomplish a purpose, some, like those to which I have called your attention, are to be placed above, others below instinct. Many of the actions of plants, such as turning the leaves toward the light, the tendency of the roots to grow downward, and the closure of the flowers at night, remotely resemble instinctive actions. In some the resemblance is more perfect—the groping of tendrils for support, for instance. Prof. Gray gives the following account of this action: "When a twining stem overtops its support, the lengthening shoot is seen thrown over to one side, and usually outstretched. One might suppose that it had fallen over by its weight, but it is not generally so. If turned over, say to the north, when first observed, it will probably be found reclining to the south an hour or two later, and, an hour later again, turned northward: that is, the end of the stem sweeps round in a circle continually like the hand of a clock. It keeps on growing as it revolves; but the revolving has nothing to do with the growth, and indeed is often so rapid that several complete turns may be made before any increase in length could be observed. The time of revolving varies in different species. It also depends upon the weather—being slow or imperceptible when it is cold, and more rapid when it is warmer. Sometimes it stops when everything seems favorable, and starts again after a while. The hop, bean, and morning-glory, are as quick as any. In a sultry day, and when in full vigor, they commonly sweep round the circle in less than two hours. They move by night as well as by day. This sweeping is the cause of the twining. The stem sweeps round in order that it may reach some neighboring support; as it grows it sweeps a wider and wider space, that is, reaches farther and farther out. When it strikes against any solid body, like the stalk of a neighboring plant, it is stopped; but the portion beyond the contact is free to move as before, and, continuing to move on and to lengthen, it necessarily winds itself round the support, that is, twines." The sudden closure of the leaf of the Venus's-flytrap, as soon as it is touched by an insect, and the excitement of the glandular hairs upon its surface, still more closely resemble the instinctive actions of animals, and we here find the power to distinguish between different foreign bodies, for Darwin has shown that, although the leaf will close upon a small piece of meat, it is not excited by contact with a small piece of glass. In animals we meet with a large class of what are called reflex or automatic actions, and these are perhaps a little nearer to true instinctive actions than most of those performed by plants. Such are the actions of the various organs concerned in digestion, which are passive until the presence of food calls them into action, when they at once begin their work. A little higher are those actions which may be performed or controlled by volition, although they are usually automatic; such as winking to protect the eye from injury, and the act of throwing out the arms when in danger of fall-

ing. These are commonly spoken of as instinctive actions, but it is impossible to separate them from the class last spoken of. A little higher than the reflex actions are the truly instinctive ones, as a type of which we may take the actions of some very young chickens, experimented upon by Mr. Spalding. In a paper read before the British Association, this experimenter says: "Chickens hatched and kept in the dark for a day or two, on being placed in the light nine or ten feet from a box in which a brooding hen was concealed, after standing chirping for a minute or two, uniformly set off straight to the box, in answer to the call of the hen, which they had never seen, and never before heard. This they did, struggling through grass, and over rough ground, when not able to stand steadily on their legs. Again, a young hawk was made to fly over a hen with her first brood of chickens, then about a week old. In the twinkling of an eye most of the chickens were hid among the grass and bushes; and scarcely had the hawk touched the ground, about twelve yards from where the hen had been sitting, when she fell upon it, and would soon have killed it outright. A young turkey gave even more striking evidence. When ten days old it heard the voice of the hawk for the first time, and close beside it. Like an arrow from a bow it darted off in the opposite direction, and crouched in a corner, and remained for ten minutes motionless and dumb with fear." These examples will serve as illustrations of pure instinct, and we will pass now to actions which are superior, but obviously similar, to the instinctive ones. Actions which are frequently repeated become habitual, and habits of long standing become so firmly fixed that the actions are performed unconsciously, and, as it were, instinctively.

Most of us can remember the labor and pains which were required in order to learn to write: the comparatively easy acquisition of the art of making down-strokes, and the tendency, which we adhered to so obstinately, to form all our letters with down-strokes, and to fill in the curves and shading afterward. Any one who has watched a child writing has observed the necessity under which it labors for counting the bends to distinguish an *m* from an *n*, and the tax which an hour's writing inflicts upon all its bodily and mental powers. Constant practice soon renders writing habitual, and the necessary muscles act mechanically, so that we are able to give all our attention to the intellectual part of the process, while the writing is done without any effort or attention. A well-drilled soldier performs the proper evolution at the word of command, although he may be so preoccupied or so fatigued as to be perfectly unconscious of his actions. Such habits are remarkably persistent, especially when they are acquired early in life, and they have nothing to distinguish them from instinctive actions except that they are unconscious.

They are often performed involuntarily, and even in opposition to a previous determination. Street-car horses soon learn to stop and

start at the sound of the car-bell, and I once saw an obstinate horse, which had resisted every other means of persuasion, start at the sound of the bell and get the car fairly under way before he had time to think what he was doing.

Every one remembers the story of the old pensioner who received the command "Attention" from a by-stander while he was returning from market with his dinner in his hand. At the word of command he instantly and mechanically dropped his dinner in the mud, and took the proper position. Occasionally in man, and quite frequently in other animals, these habits of long standing are transmitted to the next generation, and, as they are then independent of individual experience, they are true instincts. Although the art of writing is not inherited, the particular style of handwriting is very often hereditary. The act of pointing or setting in dogs would be a great disadvantage to wild animals, and there is every reason to believe that it has been very recently acquired by a few breeds of domestic dogs; yet it is frequently inherited in its highly-developed form, and the transmission of a slight tendency in this direction appears to be general. The following seems to be an instance of the appearance in the second generation, as an instinct, of an acquired habit. A correspondent of *Nature* says:

"A few years ago I bought in Skye a perfectly uneducated Skye-terrier. The first accomplishment which I taught him was that of 'sitting up'—an accomplishment which he had great difficulty in acquiring. This was not owing to any stupidity on his part, for when he had once passed over this *pons asinorum* of dog-performances, he proved to be a very clever animal, and learned many other tricks with great ease. He appears never to have forgotten the pains which were taken to teach him his first trick, and to have judged therefrom that there is great merit in sitting up. Not only does he rely upon this as a last resource to move me to take him out, or not to whip him, but he judges that it must soften the heart of an India-rubber ball. Sometimes, when annoyed at his playing with this, his favorite plaything, I have placed it on a chimney-piece, and turned my attention elsewhere.

"On looking round again, I have seen my dog sitting up to the India-rubber ball, evidently hoping that it would jump down and play with him again. My dog is now the father of a family, and one of his daughters, who has never seen her father, is in the constant habit of sitting up, although she has never been taught to do so, and has never seen others sit up. She is especially given to this performance when any other dog is being scolded.

"Whether this is an instance of helping a fellow-animal, of which Mr. Darwin gives so many curious examples, or whether the dog simply hopes to avert the storm from her own head, the fact appears to me patent that this dog has inherited the impression that sitting up has some special virtue for turning away wrath."

A little higher than the habitual actions are those which are so complicated, or occur so rarely, or depend upon such delicate combinations of conditions, that they never become habitual—that is, they

are never performed without thought, although we may be able to group them into classes, and to guide our conduct by general rules or principles, either established by experience or accepted upon the authority of others. The resemblance between these actions and the instinctive ones is recognized in common speech, for we often hear it said of a person who is guided in the main, in this way, by general rules, and is often unable to assign any reason for a particular course of conduct, that he or she is a person of fine natural instincts.

The actions of the sailor, who guides his movements by the weather reports from the Government Signal-Office, without understanding or caring much about the way in which the reports are made out, are still more rational, and further removed from instinct, although they evidently fall into the series, and have much in common with those actions last mentioned. Finally, the actions of "Old Probabilities" himself belong to a still higher class, and are eminently rational.

Reviewing the ground which we have passed over, we find that living things present us with a series of more or less related actions.

First, we have the mechanical and reflex actions of plants and animals; then the instinctive action, then the hereditary habit, then the acquired habit; next the action governed by a general rule, established by experience; and finally the rational action.

Great as seems to be the difference between the two extremes of this series when considered by themselves, it is possible to pass from one to the other through a series of intermediate actions, without the necessity for any great jump in any part of the series; and it is plain that, great as are the differences between them, they all have something in common. Let us try to discover what this something is. All the actions which we have been examining are alike in this, that they are directed to the accomplishment of a purpose. The root grows downward in order that it may reach water. The leaf turns with the sun in order that it may receive a greater supply of heat. The fly-trap closes upon its prey and pours forth its secretion in order that it may be supplied with food. The vine twines in order that its long, slender stem may be supported. The digestive organs perform their various functions that the body may be nourished and its waste supplied. The eyelids close in order that the eye may be shielded from danger.

The chick instinctively seeks its mother that it may be protected and fed; and it hides from the hawk to save its life. The dog begs and the soldier goes through his manual to escape punishment, or to gain a reward or approbation, or perhaps from a combination of all these motives with still higher ones, but in any case to accomplish a purpose. The sailor watches the weather-predictions and regulates his actions accordingly, in order that his voyage may be finished as safely and quickly as possible. And the signal-officer publishes his

predictions in order that the public may be informed as to the probabilities of change.

It may be said that in the last two or three cases the purpose is intelligently appreciated, and that they are thus separated by a sharp line from the others; but this distinction gradually shades off and disappears as an action becomes habitual, and as soon as the habit becomes hereditary it may be entirely wanting.

The well-drilled soldier goes through with his evolutions without a thought as to his reasons for doing so, and nearly every middle-aged business-man of methodical habits probably recollects finding himself at his place of business on a holiday without knowing how or why he came there. One characteristic of these various actions is, then, that each has a purpose. Another is that, although the object of the action is the accomplishment of a purpose, the cause of the action is a change, external to the organism and distinct from the purpose.

The leaf of the Venus's-flytrap closes, and the digestive organs of an animal do their work, not because food is needed, but because they are excited by the presence of a foreign body. The dog points because he scents a particular odor, not because he wishes to do his duty. The soldier assumes his position because he hears the word of command, etc. The actions which are the subject of our present lecture stand, then, in a double relationship. They are excited by certain external changes, and they have for their object the accomplishment of a purpose. Herbert Spencer has expressed this dual relationship in a simple formula. According to him, these and all other peculiarly vital actions consist in "the adjustment of internal relations to external relations." This is not very lucid when stated abstractly, but perhaps an example will help to make it clear. If I kick a stone, I may move it a greater or less distance, and set up some slight molecular change within it, and hurt my foot, perhaps. If I kick a dead dog, the result is the same; but, if the dog is alive, I shall find that all these results follow, and something more. The molecular change in the nerves of the dog gives rise to or excites a series of actions adapted to meet my attack and to prevent further injury. There is a relation, external to the dog, between the kick and a disposition to do him further violence; and there is an internal relation in the dog between the sensation caused by the blow and a desire to escape the violence which is to follow; and whether he crouches and supplicates, or puts his tail between his legs and runs, or returns my attack, he simply adjusts internal relations to external relations. There is a relation between a downward direction and the presence of water in the ground, and to this relation the roots of the plant respond.

There is a relation between the presence of a foreign body in the stomach and food to be digested; and accordingly, when the stomach is excited by the sensation of contact with a foreign body, it be-

gins its work—that is, there is an adjustment between the internal relation of a certain sensation to the digestive process and the external relation between the presence of foreign matter in the stomach and food.

There is a relation between the sudden approach of a body toward the eye and danger to that organ, and to this relation the nerves and muscles are adjusted. There is a relation between a peculiar "cluck" and the presence of the mother-hen, and to this relation the chick responds. There grows up in the mind of the soldier a connection between the word "attention" and a particular attitude, and when he feels the sensation caused by the command, he at once, and unconsciously, performs the muscular movements necessary to assume that position; that is, there is an adjustment between the internal relation of a certain sensation to certain muscular movements and the external relation of a certain command to the necessity for assuming a given position. The sailor learns that there is a relation between certain signals and stormy weather, and to this relation his actions are adjusted. Finally, General Meyer finds that there is a relation between low barometric pressure in certain parts of the country and a liability to storms in other regions, and to this external relation he adjusts his actions.

The kind of external change to which an organism may respond of course varies greatly in different cases, both in constancy and complexity. The Venus's-flytrap is adjusted only to relations between objects on the surface of the leaf and in contact with it, but an animal with even rudimentary organs of sense may respond to changes which occur at a distance. Even the simple capacity to distinguish light from darkness is enough to enable an animal to perceive a distant body between it and the sun, and to adjust its actions accordingly.

As we ascend to creatures having more developed eyes, we find an increase in the sphere of surrounding space throughout which external relations can establish corresponding internal relations. A slight convexity of the epidermic layer lying over the sensitive tract first serves, by concentrating the rays, to render appreciable less marked variations in the quantity of light, and thus brings into view the same bodies at a greater distance, and smaller or less opaque bodies at the same distance. From this point upward, through the various types of aquatic creatures to the higher air-breathing creatures, we trace, under various forms and modifications, a complicated visual apparatus and a widening space through which the correspondence extends. It is needless to go into details. Hypotheses and illustrations aside, it is obvious that from the polyp, which does not stir till touched, up to the telescopic-eyed vulture or the far-sighted Bushman, one aspect of progressing life is the greater and greater remoteness at which visible relations in the environment produce adapted relations in the organism. The extension of the correspondence in space does not end

with the perfecting of the senses. In creatures of comparatively advanced organization there arise powers of adjusting inner relations to outer relations that are far too remote for direct perception. The motions by which a carrier-pigeon finds its way home, though taken a hundred miles away, cannot be guided by sight, smell, or hearing, in their direct and simple forms. Chased animals, that make their way across the country to places of refuge out of view, are obviously led by combinations of past and present impressions which enable them to transcend the sphere of sense. And thus also must it be with creatures which annually migrate to other lands.

In man, this secondary process of extension is carried still further. Though the correspondences he effects by immediate perception have a narrower range than those of some inferior creatures, and though in that species of indirect adjustment just exemplified he is behind sundry wild and domesticated animals, yet, by still more indirect means, he adjusts internal relations to external relations that are immensely beyond the appreciation of lower beings. By combining his own perceptions with the perceptions of others as registered in maps, he can reach special places lying thousands of miles away over the earth's surface. A ship, guided by compass, and stars, and chronometer, brings him from the antipodes information by which his purchases here are adapted to prices there. From the characters of exposed strata he infers the presence of coal below, and thereupon adjusts the sequences of his actions to coexistences a thousand feet underneath. Nor is the environment through which his correspondences reach limited to the surface and the substance of the earth. It stretches into the surrounding sphere of infinity. It was extended to the moon when the Chaldeans discovered how to predict eclipses; to the sun and nearer planets when the Copernican system was established; to the remoter planets when an improved telescope disclosed one, and calculation fixed the position of the other; to the stars when their parallax and proper motion were measured; and, in a vague way, even to the nebulæ when their composition and forms of structure were ascertained. At first sight, no two things could seem to have less in common than the tendency of a sprouting potato to grow toward the light, and the preparations made by human beings for such a rare, and distant, and complicated event as a transit of Venus; yet each is, objectively considered, an adjustment of internal relations to external relations, and the two phenomena are so well connected by intermediate forms that there can be no doubt of their relationship.

Physiologists are gradually proving the statement that these and all other vital changes are, in ultimate analysis, changes in the protoplasm of the body, and that they are not brought about by any peculiar vital force, but are the direct outcome of the physical and chemical structure of the protoplasm itself; so that vital changes, considered

simply as changes, must not be regarded as peculiar, and fundamentally unlike the changes of inorganic matter.

Vital changes cannot, however, be regarded as changes simply standing by themselves, for, if we overlook their adjustment to the accomplishment of a purpose, we omit their most essential characteristic.

In so far as the contraction of a muscle is simply a change, it is without doubt purely physical; but in the adjustment of this change to a relation between external changes, in its adaptation to a purpose, we have something which has no parallel except in living things, and perhaps some of man's contrivances, such as the automatic governor of the steam-engine. Living things are distinguished from those which have not life by their adjustment, and life consists in this adjustment. Small as this difference seems when stated abstractly, and unimportant as it appears to be when we contrast such an organism as an amœba, with its simple and almost mechanical power of retracting its pseudopodia upon irritation, and such a highly-complex and changeable inorganic being as the ocean, yet, considered not in itself but in its adjustment to external relations, this power in the amœba separates it very widely from all inorganic forms of existence, and connects it with the highest manifestations of life; for the series of adjustments of which that of the amœba is one of the simplest may be traced almost without break up to the most rational actions of man. A vorticella contracts and folds down its circlet of cilia when touched, because there is a connection between violent contact and the presence of danger; and this recognition of a connection between the changes of the external world is knowledge of the order of Nature, and this, in its higher form, is experience, and experience implies memory, and memory and experience are forms of consciousness. Thus we are able to understand the meaning of such expressions as that of Haeckel, that living things are distinguished from the not living by the possession of memory. It seems best to restrict the use of such purely subjective terms as *memory* and *experience* to the higher forms of conscious life, but we must not overlook the fact that the existence of an adjustment between internal and external relations implies something fundamentally like the memory of higher animals.

Finally, I wish to call attention to the fact that natural selection is constantly acting through the law of the survival of the fittest, in such a way as to bring each organism into more and more perfect harmony with its environment; that is, it is constantly bringing about a more and more exact, definite, and perfect adjustment between external and internal relations. If this adjustment constitutes vitality, and if natural selection furnishes an explanation of the manner in which the adjustment has been brought about, have we not, in the law of natural selection, an explanation of the origin of life?—not of course of the origin of the matter of life, nor of the changes of

which life is made up, nor of the production of living beings, but of the origin of those attributes by which living things are especially characterized, and in which they differ from all other forms of existence.

SCIENCE AND WAR.

By H. BADEN PRITCHARD.

RECENT wars have had particular interest for the man of science. If we go back some fifteen or twenty years and consider the different wars which have unfortunately occurred since that time, we shall find connected with each one of them certain features which undoubtedly mark progress in the art of killing and wounding. Some argue—and on very good grounds, no doubt—that the more sharp and terrible warfare is made, the more speedily must it come to an end, and hence look with favor upon the means taken every day to render weapons more destructive and the soldier more cunning in his dangerous trade. We do not propose to discuss this argument, nor to enter at all into any comparison between the wars of our forefathers and those of to-day, but at a crisis like the present we need hardly apologize for bringing before our readers some points illustrating the marked influence of science upon modern warfare.

Starting from the close of the Crimean War, the first in which the electric telegraph was employed, we find ample examples of the assistance furnished to the soldier by scientific research. One instance taken from the war of 1858 is especially interesting. The Austrians held Venice at the time, it may be remembered, and, to protect the harbor, torpedoes were laid down. The torpedoes were fired by electricity, and contained gun-cotton, this being the first instance on record of the employment of electric torpedoes and of the newly-invented nitro-compounds. Nor was this all. The torpedo system devised at Venice by the Austrian engineers had yet another point of scientific interest. A camera-obscura was built overlooking the harbor, and upon the white table of this instrument were reflected the waters of Venice. As the torpedoes were sunk one by one a sentinel in the camera noted the place of their disappearance with a pencil, giving each torpedo a consecutive number. A row-boat in the harbor described a circle around the sunken torpedo, indicating the zone of its destructive power, and the sentinel again, with his pencil, made a corresponding ring upon the camera-table. In the end, therefore, while the harbor itself was apparently free from all obstruction, a very effective means of torpedo-defense was established, the key of which was only to be found in the camera-obscura. The sentinel here had wires in connection with every torpedo, and was in a position to fire

any one as soon as he observed—by means of the camera—the presence of a hostile vessel within the limits of any of the circles marked upon his white table.

In the American War of 1860, the electric torpedo, invented but two years before, played a most conspicuous *rôle*, and formed indeed, with the use of big guns and monitor iron-clads, one of the most important features of the struggle, at any rate from a scientific point of view. The war of 1866, when the Austrians suffered such a terrible defeat at the hands of the Prussians, will long be remembered as a combat between the old muzzle-loading rifle and the breech-loader, in which the latter was victorious. The Franco-German struggle of 1870, again, though marked by the employment of no special arm, if we except the mitrailleuse, was assisted by important applications of science; to wit, the reproduction, by means of photo-lithography, of the French ordnance maps and plans, which were distributed in thousands throughout the German army, and the establishment in France of *la poste aérienne* to communicate with the besieged garrison of Paris. The regularity with which the mails left Paris *par ballon monté* must still be fresh in the memories of our readers, the publication of correspondence from the French capital being maintained in our journals during the whole period of the investment. From September 23d to January 28th, when Paris was practically cut off from the rest of the republic, no less than sixty-four balloons left the city with passengers, mails, and pigeons, and of these only three were lost, while five were captured. The return-post by "homing pigeons" was hardly so regular, but nevertheless half the number of dispatches given in by correspondents at Tours and elsewhere, or in other words 100,000 messages, were by the unflagging energy of the postal authorities carried into the beleaguered capital. The dispatches, most of them as brief as telegrams, were distinctly printed in broad sheets and photographed by the aid of a micro-camera; impressions upon thin, transparent films were then taken and rolled in a quill attached to the tail of the winged messenger which was to bear them into Paris. Arrived at their destination, the tiny photographic films were enlarged again by the camera, and the dispatches, being once more legible, were distributed to the various addresses.

The present Russo-Turkish War cannot well be less interesting than those that have so recently preceded it, and we may especially point out two directions in which fresh examples of scientific warfare will probably manifest themselves—in connection, namely, with the cavalry pioneer and the Whitehead torpedo. Both of these will probably be seen in warfare for the first time, and before many days are past we may hear of their doings in action.

The cavalry pioneer must not be confounded with the Prussian Uhlan who played so conspicuous a part in the last war. The ubiquitous Uhlan, terrible as he was, did not work the injury which some of

the Cossacks will have it in their power to inflict if accoutred as pioneers. These are selected from the smartest and most daring troopers, lightly armed and well mounted. In a belt round their waists they carry a few pounds of gun-cotton or dynamite, and with this highly-destructive explosive they may work incalculable harm. A small charge of gun-cotton placed simply upon a rail and fired with a fuse suffices to blow several feet of the iron to a distance of many yards, thus rendering the railway unserviceable on the instant. A trooper may dismount, place a charge at the base of a telegraph pole, fire it, and be in his saddle again within sixty seconds. Wires may thus be cut and communication stopped in the heart of an enemy's country by fearless riders, who have but to draw rein for an instant to effect the mischief, while lines of railway in the neighborhood are entirely at their mercy. Even light bridges and well-built stockades may be thrown down by the violent detonation of compressed gun-cotton, and forest-roads considerably obstructed by trees thrown across, which are never so rapidly felled as when a small charge of this explosive is fired at their roots.

The influence of the Whitehead torpedo, of which we have heard so much of late, will likewise be felt for the first time during the present war. An implement so ingenious in its character that, as Lord Charles Beresford the other day happily remarked, it can do almost anything but talk, is in the possession of both belligerents, and will doubtless be heard of ere long on the Danube and in the Black Sea. These torpedoes are manufactured at Fiume on the Mediterranean, and, like Krupp guns, are to be purchased by any one who chooses to pay for them.

The British Government manufactures its own Whitehead torpedoes in this country, having paid several thousand pounds for the privilege. The machinery inside this torpedo is still a secret, which is strictly maintained by our Government, but the principle of the invention is well known. It is a long, cigar-shaped machine measuring a dozen feet and upward. In the head is a charge of some violent explosive, such as gun-cotton, or dynamite, which explodes as soon as the torpedo strikes an obstacle. The motive power is compressed air, which is forced into the machine by powerful air-pumps, immediately before the torpedo is discharged into the sea, no less than 600 pounds on the square inch being the pressure exerted. The Whitehead is shot from a tube, and moves through the water as straight as a dart, the compressed air working upon a screw in the tail of the machine. The delicate machinery permits the torpedo to swim at any depth below the surface that may be desirable, and it flies straight in the direction it is aimed, at a speed of something like twenty miles an hour. If it fails to strike the foe, then the intelligent apparatus at once rises to the surface, becoming innocuous as it does so, and may in this condition be captured without difficulty.

A torpedo of this sort striking the sides of an iron-clad would almost infallibly send her to the bottom, and although it has been proved that a network or crinoline around the ship is capable of retarding the progress of a "fish" of this nature, and exploding the same harmlessly in its toils, it is obviously a very difficult matter thus to protect one's craft. Against heavy torpedoes, indeed, there seems no way of defense at all (the Whitehead generally carries a charge of seventy or eighty pounds, but moored torpedoes may contain a 500-pound charge), and therefore Turkish vessels will have to give Russian ports a wide berth. All must remember how the magnificent fleet of the French was kept at bay by the torpedoes of the Germans in the North Sea in 1870, and the Black Sea ports are no doubt similarly protected. So demoralizing is the dread of the torpedo with sailors apparently, that they will dare anything rather than venture into waters which conceal these cruel foes.

At no other time has there been so much want of unanimity among the great powers of Europe on the subject of ordnance. There are to be found at the present moment cannon of a dozen different descriptions in the gun-parks of European nations, differing from each other not only in respect to their construction, but in the metal of which they are made. So far as small-arms are concerned, we know there is but one opinion; some nations prefer one breech-loader to another, but all agree in the employment of breech-loaders. In the case of cannon, however, it is different. Germany relies upon breech-loading ordnance, while Great Britain has forsaken the system and gone back to muzzle-loaders; Austria makes her guns of bronze, Germany of steel, Russia favors steel and brass, America cast-iron, while England has cannon of steel encompassed with iron, and France weapons of iron girt with steel.

The balance of favor is beyond question with the breech-loader at the present moment. All the new artillery of the Russians and the Turks is of this kind, while the field-guns both of the Germans and Austrians are upon the same system. France has done nothing lately for the regeneration of its ordnance, and there remain but Great Britain and Italy to represent muzzle-loading artillery. But Italy, although she has adopted the British system for very heavy guns, is by no means a confirmed believer in it, and will doubtless hesitate before following our example very far, beset, as she is, with neighbors armed with breech-loaders.

Of all the powers, it is, curiously enough, steady-going Austria which has taken the boldest and most independent course in the matter of artillery. It was but at the end of 1875 that the Austrian War-Office decided to adopt the Uchatius cannon for field-artillery, and yet at this moment every artillery regiment of the vast Austro-Hungarian army is armed with the new weapon. Within eighteen months no less than 2,000 of these cannon have been cast and finished, and now

the Vienna arsenal is engaged in the manufacture of heavy guns of the same character. Never was a more energetic step taken. A new cannon of some sort was held to be absolutely necessary to uphold the prestige of the army, and a commission having been intrusted with the selection of an arm, pronounced without delay in favor of the scheme brought forward by General von Uchatius. In October, 1874, the first round was fired from a Uchatius gun, and a twelvemonth afterward the sweeping reform which was to introduce an entirely new artillery throughout the Austrian service was decided upon. Government sanctioned an expenditure of £1,800,000 to be spent in two years, and General von Uchatius was directed to give all the assistance in his power toward the fulfillment of the design.

The Uchatius gun is made of so-called steel-bronze. Chilled bronze would be a better name, since Uchatius casts his metal in a chilled, or metal mould, in the same manner, pretty well, as Sir William Palliser produces his famous chilled projectiles. Bronze, as everybody knows, has been a favorite metal with gun-founders from the earliest days, and in the East, especially, magnificent castings of this nature have been produced. About ninety per cent. of copper and ten of tin is the mixture commonly employed in making ordinary bronze, and eight per cent. of tin is the proportion preferred by Uchatius. The difficulty in casting bronze, as those who have any experience know full well, is that of securing homogeneity, soft particles of tin becoming isolated in the mass, and giving rise to the defect known as "tin-pitting." Whether we have lost the secret of bronze-casting, or whether in former times they were more skillful at the work, certain it is that founders of the present day are unable to secure so uniform an alloy as formerly. This was very apparent when some eight or ten years ago our own Government adopted, for a brief time, bronze artillery. The addition of a small percentage of phosphorus did not mend matters, and the highest authorities on the subject were at a loss to suggest an effective remedy. Our bronze guns, too, had another defect which could not be overcome. After firing the bore became affected, and the weapon, as it was termed, "drooped at the muzzle." These were the two defects indeed that led mainly to the abandonment of the bronze gun in this country, and they are, too, the difficulties which General von Uchatius appears to have overcome. He has got rid of "tin-pitting," and his guns do not "droop at the muzzle."

Uchatius found that by subjecting the alloy in a liquid form to considerable pressure, he was enabled to secure a perfectly homogeneous mass, a result which was also furnished, he discovered, when he had gone a step further, if the molten metal was rapidly cooled. Steel-bronze is apparently made much in the same way as the toughened glass of which we have heard so much lately. After being cast in a mould, the alloy is thrust into a reservoir of oil, heated to a high temperature, so that the metal suddenly cools, but only down to a cer-

tain point. Then the casting is withdrawn and allowed to get cold more gradually. A regular and crystalline structure is in this way produced, which has none of the defects of ordinary bronze. It is a moot point whether phosphorus enters into the composition at all. Chemists tell us they can find no trace of it, but this is no absolute proof that a small percentage of the element was not originally contained in the alloy, being burned out after it had done its work of harmonizing the two metals. The inventor is rather reticent on the point, but in any case it is very certain that he produces a uniform and homogeneous alloy of a hard, crystalline nature.

One other expedient Uchatius has recourse to in making his cannon. When he has cast his gun and chilled it, he proceeds to dilate the bore. Wedges of steel, shaped in the form of cones, are forced into the tube of the gun one after another, until the calibre of the weapon has been increased by something like seven or eight per cent. This expansion or dilation of the tube has not only the effect of hardening or steeling the core, but also of rendering the gun more elastic and capable of resisting more effectually the strain put upon it at the moment of firing. The gun, after this process, is in a state of elastic tension, and it is said that there is a pressure from without, inward, equal to that which was exerted to dilate the gun in the first instance; and that this is actually the case can scarcely be doubted, since it is a fact that a section of the gun, before being quite severed, will tear itself loose with considerable violence, and will be found on separation to have partially returned to its former calibre.

So far as practical trials have been conducted with the weapon, the Austrian Government have every reason to be satisfied with the Uchatius gun, which compares favorably with the Krupp steel cannon in the matter of accuracy and durability; while, as regards its cost, it is far cheaper than any other rifled ordnance. A steel field-piece costs upward of £100, even when not protected with rings, while the iron-steel weapon, manufactured in this country, costs about £70 sterling; the steel-bronze cannon of General von Uchatius, on the other hand, are made for £35 apiece.

In construction, the Austrian gun is so similar to that of Herr Krupp, of Essen, that the latter claimed compensation for an infringement of his patent when the manufacture of the Uchatius gun was first commenced. The Essen works, our readers may know, supply not only Germany with steel breech-loaders, but have provided the present belligerents with all their modern artillery. Russia has still many brass cannon on hand, and Turkey a goodly number of Armstrongs, but both powers mainly depend upon their steel Krupps. These stood the German army in such good stead during the last war that their reputation is firmly established. They are of crucible steel, and the breech, instead of being upon a hinge, or in the form of a block, moves round in a D-shaped socket, the escape of gas being further prevented by rings of phosphor-copper.

The manner in which the ordnance of this country is constructed is sufficiently familiar to our readers. A tube of steel is encompassed by jackets of wrought-iron, and in this way the toughness of the latter is combined with the hardness of the former. All our guns, as we have said, load at the muzzle, while those of Russia, Germany, Austro-Hungary, and Turkey, are breech-loaders. Italy, in the case of the 100-ton guns with which she intends to arm her two stupendous turret-vessels, the Duilio and Dandolo, has adopted our method of construction, except that she employs smooth, instead of studded, projectiles. With the employment of a gas-check at the base of the shot to prevent windage and so secure the full force of the exploding charge, the use of studs in a shot appears to be unnecessary, sufficient spin being imparted to the projectile by the soft metal of the gas-check before named, which causes the shot to rotate after the manner of a Snider bullet. So satisfactory, indeed, were the Italian trials of these projectiles last year that it is by no means improbable that we, too, may give up the use of studded shot.

As to the comparative value of breech-loaders and muzzle-loaders, we shall not offer an opinion. No doubt a muzzle-loader is the stronger weapon, because its breech is solid; but our cousins, the Germans, urge very justly that, since their guns do not burst, they are quite strong enough. Advocates of the muzzle-loading system argue again that their weapon is more simple in construction, and for this reason is to be preferred; but on the other hand the sponging and loading of a gun is more easy to effect if it opens at the breech. Indeed, in the case of very heavy guns located in a casemate or on board ship, the Germans reproach us with the assertion that we must needs have recourse to all sorts of complicated and awkward machinery in loading, while in their case a simple pulley or crane is all that is necessary. Either, say they, we must expose our gunners through the open port when loading, or, as in the case of the Thunderer, rely blindly on hydraulic apparatus to work the guns for us. So stands the question: perhaps the present war will bring us a solution of it.—*Nature.*

THE LABOR-QUESTION.

By R. G. ECCLES.

IN sociology, the "personal equation," if not eliminated, distorts men's view of Nature's workings more than in any other department of thought. Despite this, nowhere else do they cling so tenaciously to this distorting factor. Shallow conclusions, based upon traditional notions of right and wrong, tinctured with the bias of class or education, is the sum total of the majority of attempts at making

clear this vexing but important subject. Scientific methods are unthought of, and scientific conclusions either ignored or denounced as cold, hard, and unsympathetic. They never trouble themselves about ascertaining what it is *possible to do under the circumstances*, but, without a minute's consideration, set up their Utopian standards of right, and at once proceed to bend everything in that direction. Should they deem it right to reverse the course of the Mississippi, we might almost expect to see them undertake the impossible task, careless of all disastrous consequences. They have wasted power by asking what *ought* to be done, instead of inquiring what *can* be done.

If ever this problem receives an accurate solution, it will come from viewing it physically rather than morally. As the bone and sinew of man is the stored energy of sunbeams, so property or capital is the same energy re-stored after being unlocked as work. As the former is the potential energy of physical life, so the latter is the potential energy of social life. Any attempt at viewing the matter by ignoring this law of the conservation of energy, which is at the foundation of social order, can only result in false opinions and lead to dangerous measures.[1] When men were savages, and bone and sinew ruled, he who had most physical power was chief. Now, a vaster magazine of energy is accumulated in capital, and whoever has most of it rules. This is but a plain statement of fact. The power is there lodged by the very constitution of society, and no attempts at realizing the dream of communism can wrest it away. What can the man of muscle do?

In early stages of human development, the accumulation of bodily vigor and strength was the main object of life. Natural and sexual selection conspired to pick the strongest, best-formed specimens, while driving the weak and worthless to the wall. Strategy soon competed with strength, and, when victor, intellect was picked with it. From among all the strategic devices of intellect property was selected as the fittest, and society became a necessity for its protection. As at first men found that such life as they sought could only exist when bodily waste was balanced or overbalanced by accumulation, so now we cannot long maintain physical health if nutrition fails to keep pace with waste. Some form of phthisis may take hold of us and increase the waste beyond the normal, or our supply of food may be withheld, and we die of inanition. Social life is subject to two just such sets of dangers. In a machine we have friction and interference answering to similar ideas. These must each be brought to the minimum if we would have things work smoothly.

Are working-men, as a class, frugal and provident? Do they curb self-gratification, and make present sacrifice for future advantage? How many mechanics or day-laborers calculate their annual waste of means on such unnecessary articles as tea, coffee, tobacco,

[1] When this was penned the writer did not suspect it would be so quickly verified.

beer, whiskey, etc.? How many, instead of selecting plain, wholesome, cheap food, spend their extra dollars on pastry, *rare* fruits and vegetables, etc.? The business done in this line by the grocers and bakers of the lower wards of New York will answer this. I have eaten at the tables of rich and poor in many States, and my experience teaches me that, as a rule, the well-to-do mechanic lives better than many merchants, bankers, and professional men, as long as his wages hold out. The same prodigality is manifested in dress and ornament. They will make any sacrifice to ape the rich or vie with each other. Servant-girls often dress better than their mistresses. Who will calculate the dollars wasted by that mechanic's family, before sickness or accident drove him to the poor-house? How much did he throw away on rent, that he might live in a better house than he was well able to afford? How many dollars were spent on theatres, balls, sociables, fairs, or excursions, that might have been saved? How much did superstition extort from him? These are a few of the many avenues through which his hard-earned wages escaped. Add to these the physician's bills, for attending to himself and family when overwork and uncleanliness brought on sickness; and, last though not least, consider the number of mouths he is himself the cause of having to fill, and the number of backs to clothe. If his income had overbalanced this expenditure, when the crisis arrived he would have been safe. With how many of our present paupers and tramps was this the case? Are the careful to be forced to bear the load of the careless? Self-restraint is more important to the poor man than legislation. This will give him a fitness for the battle of life, while that but unmans and effeminates him.

Again, are these men now out of employment the best types of laborers or mechanics, and the most trusty and efficient servants their employers had? Are they the honest, careful, thoughtful working-men who labored most earnestly for their employers' interests? Are those who have been retained the stupid and dishonest?—the unprofitable servants? Are they—but why proceed? The case is only too clear against the unemployed, as a class. Of course, there are exceptions. Unavoidable circumstances have doubtless thrown adrift the worthy. When a crisis comes, employers will retain those who have labored most faithfully and honestly for their interest. All others must lose employment. The improvident at once become paupers, demanding a living from their already heavily-burdened but careful fellow-workmen. If, during the age of muscle, lazy, puny men with diseased bodies, brought on by excess and vice, had demanded of the stalwart and vigorous that they must carry them on their backs, even though at their own peril, what could have been thought of them?

An army of unemployed men is clamoring for work, and the sympathetic urge their claims. "Fate is dealing hard with them," say

they; "can we not alleviate their distress?" They would invoke state aid in behalf of these social failures, and thus increase the burdens upon the employed, forgetting that "the last straw breaks the camel's back." They would increase the number of officials, and lose thousands of dollars of the people's money by theft, while only tens or hundreds were bestowed as charity. They forget that the poor millions who are the consumers are the real tax-payers. All experience has shown that only abortive effort and theft can be hoped for when the state interferes. It is already overloaded with such work, and its officers are men subject to temptation where cash is concerned. A change of these has been advocated, but this would only be a change of thieves. No one class has a monopoly of morality. There are moral and immoral men in all classes; and, unfortunately, men of light specific gravity are more apt to swim in the sea of politics than their more solid fellows. Shall we, then, resort to an indiscriminate bestowal of alms? Statistics have again and again shown that, in the direct ratio of alms-giving, there is an increase of pauperism and crime. The easier you make the pauper's life, the more of that restraint you remove which now hinders many from choosing pauperism as a profession. If you have money to spend upon them, demand an equivalent in work of some kind for every cent bestowed. This leaves them with a spark of manly feeling, and satisfies your desire to relieve their wants. I have seen philanthropic men and women refuse to purchase a cane, toy, or newspaper, from a really suffering and needy person in the street, because they either did not want the article offered or would not be troubled with it; and I have then seen them go a few steps and drop as much money as would have made the purchase into the hat of a professional beggar, who was less worthy and less needy. It was hard to escape the conclusion that the sympathetic feeling which could only be satisfied by giving without requiring aught in return was here tinctured with the unhallowed self-righteousness of the Pharisee.

In these unemployed workmen we have a vast amount of energy wasting itself in uselessness or crime. In the bank-vaults lie unused large stores of the potential energy of society. Rich and poor are suffering from the inactivity. What is the cause of this? The capitalists will make no new investments, as they will not pay. Business is stagnant. People refuse to purchase. Such is the general cry, and over-production takes the blame. Over-production of what? How can an over-production of wheat and potatoes produce an over-production of everything else? How happens it that all the industries appeared to collapse together? Was there over-production in all? Has each person in these United States got all the clothing and articles of comfort and luxury he can possibly desire? How can over-production be chargeable with this state of affairs, when, by a little thought upon the matter, we might see that the evidence points to

the fact that every increase of goods brings a corresponding increased demand for such goods?

If there is one thing more than another working-men long for, it is high wages. To keep up their pay they unite in trades'-unions and analogous combinations. The employer wages war against this effort. While the former would demand all the profit of his labor, leaving the latter nothing for his pains, he in turn would like to retain it all for himself. If these were the sole factors of this battle, wages would steadily ascend, the balance of force ranging upward. Unfortunately (?) for the workman, this is not the case. His own unconscious efforts to pull wages down outweigh his conscious efforts to keep them up. Can he not see that every time he deserts a dear dealer to buy from a cheap one he is thoughtlessly creating a tendency to lower the wages of all who take part in the manufacture of such articles? This eventually, and through a variety of channels, works around to his own. This move on his part likewise creates a necessity for dishonesty and adulteration, which still further reacts against him. His employer, on the other hand, does more toward keeping up wages by seeking dear markets for his goods than his conscious efforts amount to in pulling them down. As the heaviest strain on the produce of the workman is the downward one, since all consumers take part in it, *wages must fall.* All the world clamors for cheap goods. Eventually a point of stable equilibrium must be reached, where very low wages precede very cheap goods. As capitalists, studying the cost of production, hold on to goods, refusing to sell at a sacrifice, their sales descend or cease, and wages are thrown down first. Could working-men be made to realize the fact that high wages mean correspondingly high food, clothing, fuel, rent, with all else he would purchase, while low wages mean the opposite, I think they would agree with me in saying that the amount received per diem for their work was of secondary importance. Some laborers must take the shrinkage in advance of others.

That there are more goods in the American market than is at present demanded, under existing conditions, is a certainty. But if over-production has glutted one market, why not seek another? Why stop mills and factories? Why turn laboring-men into the street? Is there no channel of least resistance for business to travel in? An over-production of goods is an over-production of wealth. Has the nation more wealth and comfort than it can manage or knows what to do with? The thing is perfectly absurd. When railroads came they brought an over-supply of accommodation for stage-coach travelers, but this extra amount of room found a use for itself in making travel cheaper and more comfortable, so that immensely more people traveled. Every labor-saving machine has done the same for the articles it produces. But suppose the price of travel had kept up, and the comforts remained the same, while the means of carrying

passengers had rapidly increased, what would have occurred? Suppose the cotton machinery had turned into the market millions of yards of cotton, where hundreds answered before (as is actually the case), and the manufacturers had charged the old prices, what would have happened? It is obvious that in the first case not one extra traveler would have gone from home, and the much-needed railroads would have been a nuisance; while, in the second, the manufacturers would have been deluged with their own stock, been compelled to close their factories and howl "Over-production!" *Whatever arrests the descent of prices, entails upon society just such a state of affairs as we are passing through.* It stops wide distribution, as the owners of such goods are unable to cope with the traders of foreign markets. Protectionists aid in this part of the trouble. It accumulates a heavier supply than is demanded in the home-market. It overwhelms factories with their own goods, and drowns the manufacturer in bankruptcy, unless he stops work. It turns worthy, as well as unworthy, working-men adrift. It brings on all the horrors so piteously complained of. What can avert such consequences? There are, doubtless, factors in this problem unnoticed here, but this to me appears to be the main one. Allow wages to descend steadily, as the market demands, instead of holding them up till a crisis is reached. When crises come, they hurl them down like an avalanche far below the true level at which they should rest. Let the machinery of society have free, unimpeded action. Teach laborers to give way to the inevitable, without clogging the wheels by "strikes." They must learn to give in to the decrees of Fate without a murmur. They frighten themselves with a bugbear of starvation from low wages, and bring in a real bear with their acts. "O ye of little faith!" Will they never learn that eight hours' work at one dollar, with goods at half-price, is far better than four hours' work at the same, with goods at full price? Trades'-unions are waging war against natural law. Wages must come down! Profits must decrease! It is absolutely impossible to keep these up and have business proceed. If not satisfied with the pay offered by one employer, seek another. Unions, when other than a council of working-men aiming at the common good, are positive evils. Society must learn to frown down every interference on their part with the workings of trade, or we will be continually subject to recurrences of business stagnation and violence. They thwart their own purposes and entail the very miseries they profess to cure. Labor, like everything else in the market, is worth neither more nor less than supply and demand put upon it. It is sheer madness to battle fact by saying it should be worth more. Imagine an astronomer as insane as this, insisting upon it that the sun ought to revolve around the earth, and therefore refusing to reason upon the fact that the earth revolves around the sun! Merchants have no right to force each other, by mob

violence, to maintain high prices upon their wares. No more have working-men this right when selling their labor. When they find it necessary to employ each other, they are just as exacting as the capitalists in demanding well-done work at low rates.

The capitalist will gladly welcome all unemployed laborers when the prices of his goods can be regulated by the demand for them, instead of, as now, by the high wages he is compelled to pay his men and high prices for his raw materials. He will have no fear of overstocking the markets of a world where men's wants are so numerous and insatiable. But it will not do to let him toy with men's wages at every whim he has. Men must seek for the highest remuneration without combination, compulsion, or restriction. Business-men must seek the highest prices in the same way. Excessive selfishness on the part of employé, as well as employer, lies at the root of the matter. When this is toned down, and each works for the other's interest, things will go better with both. Till then we may expect to see misery, and hear the wail of want from many quarters. Relieve this by giving the laborer something to do, however trifling, and not by alms. Ask the state to do nothing, or you will impose extra burdens upon the worthy, and sink them to pauperage. Teach working-men to live more economically, and practise self-restraint. Advise them to compete with each other in doing the most and best work they possibly can for their employer while in his employ. Teach them that they bring down their own wages, and that this is not their employer's doings. Show them that, if the wages descend slowly and steadily, it will avoid a crash of business, and, making goods correspondingly cheap, do them good rather than harm in the end. Train them into that true spirit of freedom and faith that will enable them to allow fellow-workmen, who are in need, to sell their labor for what they choose. Teach the employers to work for the interests of their men. Teach them to be less avaricious in demanding high profits for themselves. Teach them to give the working-men the highest wages the market will allow. Teach them to be honest and truthful with each other, and the public. Teach each class these points, and the highest substantial advantages to the working-class will soon be realized as a living fact. The present and past troubles are the legitimate fruits of our social immorality. The poor are not the only sufferers. Things, as they now exist, are about the best possible to our present stage of development. With improvement of men's natures will come a corresponding improvement of society. All that we can do is to search after the laws governing such matters, and remove obstructions from the way. With this done, leave all else to the *vis medicatrix naturæ*.

SKETCH OF PROFESSOR SIMON NEWCOMB.

PROF. NEWCOMB was born in the Province of Nova Scotia, March 12, 1835. Both of his parents were of New England descent, their families having emigrated to the Provinces at various times. His father pursued the avocation of village schoolmaster, and from this circumstance the son during his childhood enjoyed educational advantages which were good for the time and place, but exceedingly scanty when measured by any other standard. A taste for arithmetic was developed at a very early age, and before he was twelve years old the embryo astronomer had completed the (restricted) course taught by his father.

From this time he was thrown upon his own resources, reading and studying at random the few books which Providence threw in his way. A traveling peddler sold him Latin and Greek grammars and readers. For a short time he studied the rudiments of French, with a teacher, but acquired a better knowledge of the language from the descendants of the old French settlers, while at the same time an algebra, borrowed from a clergyman, was his constant companion.

At the age of eighteen we find him in the State of Maryland, teaching school—his ancestral calling—but with his active mind constantly engaged in mathematical pursuits. In 1856 Mr. Newcomb was so happy as to make the acquaintance of Prof. Henry, of the Smithsonian Institution, with whom he had corresponded on a scientific subject, and who soon took an active interest in the welfare of his newly-discovered young friend. In conjunction with Mr. Hilgard, Prof. Henry secured for young Newcomb a position as computer for the "American Nautical Almanac," the office of which was then located at Cambridge, Massachusetts.

Here Mr. Newcomb found both the material and the incentive to pursue his mathematical studies of the theories of the celestial motions. He enrolled himself a student of the Lawrence Scientific School, and attended the lectures of Prof. Peirce. After making a study of the works of Laplace and La Grange, he started on the line of original investigation, and has ever since pursued it, with uniform success. In 1861 he was appointed Professor of Mathematics in the Navy, and assigned to duty at the Naval Observatory, Washington, with which he is still connected.

In 1863 he married Miss M. C. Hassler, daughter of the late Surgeon Hassler, United States Navy, and granddaughter of the late Prof. Hassler, the originator and first Superintendent of the United States Coast Survey.

It may seem surprising that, while Prof. Newcomb's name is not

associated with any brilliant discovery or achievement in astronomy, he has, nevertheless, secured as great a reputation as was ever gained by an American astronomer, and is quoted abroad as among the highest authorities in mathematical astronomy. Perhaps the secret lies in the unity of purpose which has characterized all his efforts. His special field has been that of "exact" astronomy—the prediction of the motions of the heavenly bodies from their mutual gravitation—the perfection of the tables and other data, from which the "Nautical Almanac" is prepared, in order that the navigator and surveyor may be enabled to find their positions by sea or land. When the late Admiral Davis founded the "American Nautical Almanac," some twenty-five years ago, the tables and other materials for its construction were extremely imperfect, but Prof. Newcomb's studies have all tended to their improvement.

Prof. Newcomb gained a European reputation while still a computer at Cambridge, by his paper "On the Secular Variations and Mutual Relations of the Orbits of the Asteroids." The question of the correctness of Olher's theory, that these bodies resulted from the explosion of a single planet, had never been decided, because no one had ever investigated the changes which their orbits had undergone in past ages. This was done in the paper we have mentioned, and it was shown that the orbits could never have intersected in a single point, unless they had in the mean while been deranged by some unknown cause.

Since his appointment in the navy his most considerable works, outside of his duties at the observatory, have been the "Investigation of the Orbits of the Two Outer Planets, Uranus and Neptune," accompanied by elaborate tables, which were at once adopted in all the nautical almanacs of Europe and America. In the preparation of these "tables," Prof. J. Henry, his kind and firm friend of now more than twenty years, took great interest, and gladly assisted him by supplying him with funds from the Smithsonian.

In 1867 the observatory published his "Investigations of the Distance of the Sun," leading to the value of the Solar Parallax now most generally adopted, namely, 8″.848.

In 1870 he visited Europe to observe the total eclipse in the Mediterranean, and was everywhere received with the highest distinction in scientific circles.

He took an active part in procuring the great telescope for the Washington Observatory, and was in charge of it during the first year or two after its erection, investigating with it the satellites of his two favorite planets, Uranus and Neptune.

When Congress authorized the organization of parties to observe the late transit of Venus, Prof. Newcomb was appointed one of the commission to prepare the plans for those parties, and to arrange for the complete execution of those plans, after the return of those parties

to the observatory. From the first meeting of this commission Prof. Newcomb has acted as secretary thereof. Prof. Newcomb's most recent labors have been on the motion of the moon, and the possible variability of the sidereal day, on which subject he has published several fragmentary discussions. Hansen's tables of the moon have deviated from observation for several years past in a remarkable manner, and he has accounted for the changes by an acceleration in the rotation of the earth on its axis. It is now considered that he has proved the actual existence of this acceleration beyond reasonable doubt.

In February, 1874, he was the recipient of the gold medal of the Royal Astronomical Society of Great Britain. The presentation was preceded by an address by the president, Prof. Cayley, in which, after giving an account of several of Prof. Newcomb's most important contributions to mathematical science, he says: "They exhibit all of them a combination, on the one hand, of *mathematical skill and power*, and, on the other hand, of *good hard work*, devoted to the furtherance of astronomical science." Thus, though belonging to the younger generation of astronomers, Prof. Newcomb has received his full share of honors, both at home and abroad. Graduating as B. S. at Harvard University, in 1858, he is now, *at home*, member of the National Academy of Science, and of the American Academy of Arts and Sciences, in Boston. In 1876 he was elected President of the American Association for the Advancement of Science, and presides at its annual meeting, in Nashville, in August of this year. In 1874 he received the honorary degree of LL. D. from the Columbian University, at Washington, and in 1875 the same honor from Yale. *Abroad*, he was, in 1872, elected associate member of the Royal Astronomical Society of Great Britain; in 1874, corresponding member of the Institut de France; in 1875 he received the honorary degree of Ph. D. from the University of Leyden, at its three-hundredth anniversary. Also in that year he was made a member of the Imperial Academy of Sciences of St. Petersburg, member of the Royal Swedish Academy of Sciences, and member of the Royal Bavarian Academy of Sciences.

CORRESPONDENCE.

To the Editor of the Popular Science Monthly.

SIR: In the last number of THE POPULAR SCIENCE MONTHLY Mr. E. R. Leland replies to my article in the July issue entitled "Over-Consumption, or Over-Production?" misstating some and misconceiving other of my arguments. It would be an infringement on your space for me to follow Mr. Leland through all his assertions, and at best I should be only repeating arguments already made. But Mr. Leland attempts to formulate my theories, and, as I think I can do this more accurately than he, permit me to reaffirm what I have said in this compact form, which will be the briefest and most satisfactory method of meeting Mr. Leland's reply:

1. The resources of Nature are gratuitous; they are practically exhaustless; and, as the activity of capital and the energy of labor are not fixities, large consumption or demand (Mr. Leland talks of *wasteful consumption* as if the word "wasteful" were mine) stimulates the energy of capitalists, leads to the application of improved machinery, brings about better transportation, so that as a result all, or nearly all, products are proportionately increased in abundance because of extended consumption, and the possibilities of consumption. Mr. Leland says: "That the demand for a commodity stimulates the supply is most true, and, where increase is possible, the supply is increased until the widest area of demand is filled at a minimum cost, but it is only by economy that this minimum can be reached." We repeat Mr. Leland's words —"most true." But large consumption is a powerful agent in securing minimum of cost in production; it brings in competition, it leads to the invention of machinery and improved methods of production or manufacture—in fact, minimum of cost is never reached except in those things that are in general use. Consumption or demand leads, therefore, as a rule, not only to greater abundance, but to greater cheapness. But I do not mean, and I did not speak of, *wasteful* destruction, which Mr. Leland dwells upon so much, but of *use*. Waste is foolish, in the first place, because it confers no good upon any one; and, secondly, because it is only the certainty and regularity of legitimate use that exercise a healthful stimulus upon production. Waste, that destroys machinery, permits bridges to go into decay, destroys roads, lets grain rot in its storehouses, burns up cities, exhausts the reserves of capital, is direful; but *use*, which is the means of setting millions of busy hands to work, is another thing. I know the economists say that capital alone determines the fact of production, demand merely governing the direction it shall take; but is it not clear that, if we reduce consumption to its minimum, production will shrivel up?

2. The extravagance of an individual has some essential difference from the extravagance of a whole community. Of course, one bankrupt multiplied ten thousand times simply gives us ten thousand bankrupts. It was scarcely necessary for Mr. Leland to point this out. But a community considered as a unit has for its resources the boundless wealth of Nature, which, as we have already seen, increases with the demands made upon it, so that liberal use makes rather than reduces abundance. This proposition hangs upon the first; if that is true, this is true. By extravagance I simply meant free use, not idle destruction; and what I wished to show is, that Nature yields her treasures in increasing proportion to the activity that demands them, so that we are richer in coal, iron, fabrics, food, etc., because our wants are many, our demand eager, our use of these things abundant. It is perfectly true that if the wealth of a community is simply the aggregate incomes of its members, then the whole must partake of the nature of its parts; but there is a kind of wealth that accrues to the individual and does not to the community as a whole, such as *rent*, for instance, which, enriching some, is a tax upon others, and no addition whatever to the sum total of the wealth of the community; and in like manner there is wealth which accrues to the whole, but is not a part of an individual's income.

3. Mr. Leland makes me affirm that no part of the nation's capital has been lost in unproductive enterprises. There have been, as all know, immense losses in foolish railroad and speculative enterprises; but I consider these losses to have fallen upon our surplus rather than our reserves; that our ability to keep all our machinery in motion, to run our mills, erect warehouses, build ships, construct railroads really needed, do all forms of legitimate productive labor, is not impaired — while, according to Prof. Price, it *is* impaired, and this is the reason of our business distress. I can detect no evidence that business cannot revive be-

cause of insufficient capital, the difficulty being rather that capital is lying idle.

4. I am accused of attributing the business depression to over-production, whereas I distinctly said *speculative* over-production—over-production brought about by centralization of wealth and vast appliances of machinery, which under artificial stimulus produces an excess at one period, and then at another, stopping all production, turns hosts of workmen into the streets idle and empty-handed, followed consequently by a great reduction of consumption.

5. I laid no stress upon coöperation to regulate production, merely mentioning it as the only remedy I could suggest. Such coöperation is doubtless impracticable except to a limited extent. The fear is, there is no remedy, and that we shall have—as, indeed, has been frequently predicted—continually our intermittent periods of overtrading and speculation, offset by those of prostration and suffering. The elimination of speculation and other "crazes"—that is, the maintenance of production in legitimate and healthful relation to consumption—is, as I think, indisputably the only remedy; but how this is to be brought about is more than I can say. Economists, surveying the broad field over long distances of time, are contented to say that these periods are but perturbations; that production in the end does adjust itself to consumption. While this is true, our concern is how to reduce the intensity and duration of these perturbations.

There are other points that call for answer in Mr. Leland's letter; he gives me some elementary instruction as to the meaning of capital and of money; and he decries the fact of "released labor;" but it seems unnecessary for me to take your space merely to vindicate my opinions or to establish my knowledge of elementary principles—your readers can have no concern in these matters. The thing is, to get at the truth of the causes of our business distress, and those interested are referred to the article of Mr. David A. Wells—than whom there is no better authority—in the last *North American Review*, wherein we are told that the community is suffering today, "strange as the proposition may at first thought seem, not because we have not, but because we have; not from scarcity, but from abundance;" that is, not from impaired capital, according to Prof. Price; and that "the only remedy is the creation of more wants or demands for our products, and, as a consequence, more and enlarged employments for our labor." That is to say, it is not by the community economically reducing consumption to its minimum that a revival of trade is to come, as we hear asserted on every side, but by the creation of new wants, by the stimulus of consumption. This is the essential basis of my argument.

With respect, yours, etc.,

O. B. Bunce.

"THE TIDES."

To the Editor of the Popular Science Monthly.

The article on "The Tides," in the July number of your Monthly, would be amusing had it not appeared in a scientific periodical of high standing; but, when such erroneous and ill-digested views are set forth in a reputable journal for public instruction, they call for a public notice which they do not at all deserve.

The author of the article referred to has unfortunately adopted the errors of statement and conception generally found in our text-books of natural philosophy, prepared by authors of no authority, for our public and preparatory schools. I have had occasion recently to examine several such books on the subject of "Centrifugal Force," so called, and have found very few that are not in error. If the author of "The Tides" had expended a portion of the time devoted to the elaboration of his subject in an examination of the basis of his explanation—centrifugal force—he could not have reached conclusions at variance with the simplest fundamental principles of physics.

Newton's first law teaches that a body, once set in motion, will continue to move on with uniform velocity in a straight line forever if left to itself. To produce circular motion a constant force directed toward a fixed point must be applied in addition to the original force. The fixed point then becomes the centre of revolution. The original impulsive force (or continued force acting during a finite time), and the constant force directed toward the centre, are the *only* forces concerned in uniform circular motion. "Centrifugal force" expresses merely the resistance of a body to deflection from a straight line in which it tends to move, according to Newton's first law of motion. It is its *inertia* with reference to motion in a specified direction toward the centre. If only that which produces or tends to produce motion or change of motion is force, then there is no such *force* as "centrifugal force;" for the only motions that a body moving in a circle has are tangential, due to the original impulsive force, and the radial *toward* the centre, due to the constant centripetal force. If the centripetal force ceases to act, the body moves on tangentially, in obedience to the tangential force; if its motion of rotation ceases, it falls toward the centre. It can take no other direction of motion unless some force, additional to those required for uniform cir-

cular motion, is impressed upon it. "Centrifugal force" is a misnomer—a convenient fiction to represent resistance. Resistance or inertia only *opposes* motion; it never *produces* it; and is, therefore, not *force*. Hence any explanation of phenomena that assigns "centrifugal force" as the *real* cause in producing motion or change of motion is wholly erroneous, and subversive of Newton's first law. No such resort to "centrifugal force" is necessary in the explanation of the tides.

I must confess entire ignorance of the experimental demonstration that bodies weigh more or are heavier at midnight than at any other hour of the twenty-four. If that *be true*, and the cause assigned by Prof. Schneider a sufficient explanation, then the lunar midnight should produce the same effect as the solar. On this point allow me to quote from Sir William Thomson and Prof. P. G. Tait's "Treatise on Natural Philosophy," vol. i., page 662. The authority of these physicists must be acknowledged: "Hence as the moon or anti-moon (an imaginary moon 180° from the real one) rises from the horizon to the zenith of any place on the earth's surface, the intensity of apparent gravity is *diminished* by about $\frac{1}{9000000}$ part; and the plummet is deflected toward the point of the horizon under either moon or anti-moon by an amount which reaches its maximum value when the altitude is 45°. The corresponding effects of solar influence are of nearly half these amounts."

Does Prof. Schneider mean to subvert Newton's third law that action and reaction are always equal? If he can prove that the centripetal force for any point of a revolving body is greater or less than its reaction, the "centrifugal force," he will certainly *disprove* Newton's law, and compel a reconstruction of most, if not all, mechanical propositions.

His statements respecting the value of "centrifugal force" (properly centripetal force or acceleration toward the centre) as depending on the radius of curvature are incorrect. It is not unconditionally true that "in a short curve the centrifugal force is very great." On the contrary, if the *time* of revolution is *constant*, the "centrifugal force" varies directly as the radius, increasing as the radius increases. If the *velocity* of rotation is constant, "centrifugal force" varies inversely as the radius, increasing as the radius decreases. Neither of these conditions is met in the comparison of the revolutions of the earth and the moon in their orbits, since neither times nor velocities are the same in the two orbits. In fact, the acceleration of the earth (and, therefore, of the moon) toward the sun is about $\frac{33}{100}$ of an inch; while that of the moon toward the earth is a little less than $\frac{11}{100}$ of an inch a second. The acceleration of the earth toward the common centre of gravity of earth and moon is only a small fraction of the moon's acceleration toward the same point. These accelerations are the measures of "centrifugal force." Hence, according to Prof. Schneider's theory, the solar tide should be many times greater than the lunar.

My amazement reaches a climax when I read, near the close of the article in question, that "centrifugal force acts in a line tangent to the earth's orbit;" or, "in a direction at right angles with the radius-vector." Really, Mr. Editor, your compassion should have saved Prof. Schneider from making such an egregious blunder.

In reference to the true explanation of the tides, the length of this communication will allow me to add only that, if Prof. Loomis, in his admirable "Treatise on Astronomy," had applied to the tides the same explanation and figure, *mutatis mutandis*, that he uses in estimating the amount of the sun's disturbing effect on the moon's motion, no uncertainty would remain in the mind of teacher or student respecting the cause of the tides.

H. S. Carhart.

Northwestern University,
Evanston, Illinois, *July* 2, 1877.

"THE ZODIACAL LIGHT."

To the Editor of the Popular Science Monthly.

Prof. Brame's article on "The Zodiacal Light," in The Popular Science Monthly for July, may make a recent observation of that phenomenon of interest. About eight o'clock in the evening of July 3d my attention was called to a peculiar appearance of the sky. The sun had been below the horizon about an hour. From the point in the horizon where it was last seen a broad band of pink or rose-colored light followed the ecliptic across the sky to the opposite horizon. Its south limit was sharply defined—its intensity nearly the same from horizon to horizon. Its north limit was not determinable, the pinkish light extending nearly or quite to the horizon, filling the entire northern sky. The southern sky from the ecliptic was of the normal blue color, with the exception of a single streak of a darker blue, extending from the point where the sun sank below the horizon about 90° into the southern sky, making an angle of say 30° with the southern limit of the rose-colored light, or the ecliptic.

There were none of the auroral characteristics. The light was steady, and the entire exhibition as described lasted for twenty minutes, when it all faded away gradually, leaving a perfectly clear sky, with only a trace of the pink in the west.

Charles A. Morey.

Winona, Minnesota, *July* 5, 1877.

To the Editor of the Popular Science Monthly.

READING an item, attributed to a writer in *Science Gossip*, on the "Food of the Water-Tortoise," in the "Popular Miscellany" of your July number, showing that that reptile appears "to have a special relish for the food of the cat," it occurred to me that I might also relate a fact which came under my own observation bearing upon this subject: During last summer I found an ordinary snapping-turtle (*Chelydra serpentina*) in a field adjoining my residence, and near a brook which empties into Boone River, a few rods below. It was a vicious old fellow, and more than ordinarily curious to me from the fact that it had more than a hundred leeches clinging to its shell and various portions of its skin. I had some suspicions that my captive had committed depredations upon my young black Cayuga ducks; but disliking to murder it "in cold blood," I let it go, and it speedily disappeared in a deep hole in the brook. Some days afterward, while passing near the place, I heard a duck squawling and splashing in the water, and went at once to learn the cause. I found that this same turtle had seized one of my ducks by the foot, and was trying to drag her under the water —for "carnivorous purposes!" The duck was full-grown, and would have weighed five or six pounds, but would soon have been killed if I had not rescued it. I got hold of the bird and drew her to the shore, but the turtle held on, till I was able to secure him. Of course, he caught no more of my ducks.

But this reminds me of another interesting fact. These black Cayuga ducks—said to have descended from ancestors captured at Cayuga Lake, New York, by reason of long domestication and high feeding—have come to have very heavy bodies and short, small wings. Owing to the disuse of the latter, they have become so far atrophied that "well-bred" birds are quite incapable of flight. In the summer of 1875, one of my half-grown ducklings had the misfortune to lose one of its legs. After some days' absence it hobbled home from the river on one foot, the other having no doubt been torn off by one of these same predacious turtles. The little bird speedily recovered from the injury, though it never attained the full size of its mates. It hopped about quite briskly on its single foot, using its wings to surmount obstacles or increase its speed. The consequence was that its wings grew to such size and length that it was capable of flying twenty or thirty rods, and possibly much farther. It could rise easily out of the water, and once on the wing was able to clear the bank and a high fence—in all, a quite abrupt rise of fifteen or twenty feet —and thus speedily reach home, while its mates were slowly waddling through the grass. My flock of ducks showed in a striking manner the result produced by the long disuse of their wings; while the unfortunate one-legged bird as strikingly evidenced how rapidly "compulsion to more diligent use" produced a very decided and important modification of the wings, increasing their strength, as well as the length of the feathers.

CHARLES ALDRICH.

WEBSTER CITY, IOWA, *July* 6, 1877.

EDITOR'S TABLE.

SPECTROSCOPIC DISCOVERY OF OXYGEN IN THE SUN.

CELESTIAL chemistry has taken another stride forward. In a paper recently read before the American Philosophical Society, and printed in the *American Journal of Science and Arts*, Dr. Henry Draper announces the discovery of oxygen gas in the sun, the fact being arrived at and verified by a long course of spectroscopic observations.

Viewed in any of its numerous aspects, this discovery is of immense interest. Whether as an extension of our knowledge of solar physics, solar chemistry, and the nature of the spectrum itself, or as throwing further light upon the constitution of the universe; whether as bearing upon cosmical theories that have attracted much attention, or as a triumph over the difficulties of complicated experiment, or, finally, as an illustration of hereditary genius in science, where a line of research opened brilliantly by the father nearly half a century ago, has been pursued with equal brilliancy to this crowning result —however regarded, this exploit of the younger Draper must command unqualified admiration.

As has been repeatedly shown in our

pages,[1] the elder Draper was one of the early and most successful explorers of the chemical relations of the luminous spectrum. He was a pioneer in this line of investigation, and the first to make extensive use of photography in this branch of research; and he was so far in advance of his time, that his discoveries were totally unappreciated. But he furnished the fortunate men who followed him with their tools to reap the splendid harvest of spectroscopic discovery, which has so impressed the world during the last eighteen years. We have never had any doubt that history would set all these things right, but the venerable doctor will at any rate be easy in the assurance that the sceptre has not departed from his family.

When it was established that the light emitted by vaporized and incandescent bodies gives spectra by which they may be identified, the passage was rapid to the discovery of chemical substances by the analysis of light. A study of the spectra of the sun and stars soon gave evidence that they contained forms of matter with which we are familiar upon earth. All the metals, for example, in a state of luminous vapor, yielded bright lines in the spectrum so distinctive in each case that there was no possibility of mistaking them. When these were carefully mapped and compared with the spectra from the sun and stars, such a startling mass of coincidences was at once disclosed, that there was no escape from the conclusion of a common causality, or that these metals exist also in the stellar bodies. There was but one serious difficulty. The lines obtained by the combustion of the metals were bright and colored, while the corresponding lines in the solar and stellar spectra were all dark. Kirchhoff resolved the difficulty in 1859, by showing how the bright lines may become dark lines by absorption in such conditions as the celestial bodies furnish; and it was thus not only established as a fact that there are various terrestrial metals in the sun and stars, but their mode of manifestation was brought into complete harmony with theoretical requirements.

The nebular hypothesis, which had been growing for a century, and which assumed the origin of all the bodies in the solar system from a common nebulous source, was, of course, at once and profoundly affected by the new revelations. It was proved that there are common elements extensively distributed among celestial bodies, which confirms the hypothesis that they have a common origin. Not only was there new and positive proof of the existence of nebulous matter in the celestial spaces, but the ultimate elements of which material Nature is constituted were shown to be universal, and the nebular hypothesis was thus strongly confirmed. Yet a difficulty at once arose, that the main predominant elements of terrestrial Nature were not found to exist in the sun and stars. The evidence, of course, was negative, but it was held by many to be weighty, in disproof of the nebular doctrine. If the non-metallic elements, it was said, which form the principal part of terrestrial objects, do not exist in the sun, the derivation of that body and of its encircling planets from the same primeval source is impossible. Dr. Draper has now proved that oxygen in large proportions exists in the sun (and probably nitrogen also); and his discovery can therefore only be regarded as lending further and more powerful confirmation to the nebular hypothesis.

Dr. Draper's paper, in the *American Journal of Science and Arts*, is accompanied by an illustrative diagram, which brings the demonstration before the eye of every reader. It exhibits the spectrum of the sun, and that which is produced from air, so juxtaposed that the fact and the extent of the identity of the lines in the two representations are

[1] *See* POPULAR SCIENCE MONTHLY, vol. iv., p. 361; vol. ix., p. 290.

seen at a glance. The matching and identification are even more complete than they were in the original experiments of Kirchhoff with the metals, for here it is not necessary to invoke a theory for the unification of bright and dark lines; the bright lines of the spectrum of oxygen being continuous with the bright lines of the solar spectrum. It is, indeed, because the solar oxygen reveals itself by bright lines that these have not been earlier detected, as they have been masked and concealed among the unoccupied luminous spaces, between the dark lines that have hitherto been the main objects of attention.

Dr. Draper has been occupied for several years with this investigation—in fact, he has grown into it. Besides his inherited aptitude, and life-long training in this delicate line of manipulation, and his thorough familiarity with the peculiar difficulties of these investigations, his work could only have become successful by means of a combination of appliances, some of which are only lately available. His task was to produce a gas spectrum, and maintain it at a brilliancy which would admit of its being photographed alongside of that of the sun itself. Oxygen is made incandescent by electricity. The most ample, steady, and sustained command of this agent was therefore indispensable. This was secured by the Gramme machine, a dynamo-electric engine connected with a large induction-coil and a battery of Leyden-jars. The impulse was furnished by a Brayton's petroleum-motor, which "can be started with a match, comes to its regular speed in less than a minute, and preserves its rate entirely unchanged for hours together." This was belted to the Gramme machine, which, at its usual rate of running, gave 1,000 ten-inch sparks per minute. This "torrent of intense electric fire," consisting of twenty ten-inch sparks per second, was passed through Plücker's tubes, containing oxygen, the spectrum of which is thrown upon a sensitive photographic surface, while the solar spectrum is formed beside it, and both are fixed together upon the tablet. The embarrassments of the investigation are thus referred to in Dr. Draper's paper:

"This research has proved to be more tedious and difficult than would be supposed, because so many conditions must conspire to produce a good photograph. There must be a uniform, prime-moving engine of two-horse power, a dynamo-electric machine thoroughly adjusted, a large Ruhmkorff coil with its Foucault break in the best order, a battery of Leyden-jars carefully proportioned to the Plücker's tube in use, a heliostat which of course involves clear sunshine, an optical train of slit, prisms, lenses, and camera well focused, and, in addition to all this, a photographic laboratory in such complete condition that wet, sensitive plates can be prepared which will bear an exposure of fifteen minutes and a prolonged development. It has been difficult to keep the Plücker's tubes in order; often before the first exposure of a tube was over, the tube was ruined by the strong Leyden sparks. Moreover, to procure tubes of known contents is troublesome. For example, my hydrogen-tubes gave a spectrum photograph of fifteen lines, of which only three belonged to hydrogen. In order to be sure that none of these were new hydrogen-lines, it was necessary to try tubes of various makers, to prepare pure hydrogen and employ that, to examine the spectrum of water, and finally to resort to comparison with the sun."

In regard to the significance of the inquiry in relation to spectroscopic study, Dr. Draper remarks:

"We must, therefore, change our theory of the solar spectrum, and no longer regard it merely as a continuous spectrum with certain rays absorbed by a layer of ignited metallic vapors, but as having also bright lines and bands superposed on the background of continuous spectrum. Such a conception not only opens the way to the discovery of others of the non-metals, sulphur, phosphorus, selenium, chlorine, bromine, iodine, fluorine, carbon, etc., but also may account for some of the so-called dark lines, by regarding them as intervals between bright lines."

SEELYE ON CIVILIZATION AND RELIGION.

THE inaugural address of Prof. J. H. Seelye, upon assuming the presidency of Amherst College, has attracted the marked attention that was to have been expected from the eminent scholarship and versatile accomplishments of the author. The interest, moreover, has been especially heightened by the intrepidity evinced in his choice of a subject. President Seelye did not shrink from the responsibilities of the occasion. Taking the helm of a leading orthodox institution for the education of young men, founded we are told "as a breakwater to Harvard, which had been captured by Unitarianism," and, therefore, as a bulwark of evangelical faith, he addressed himself to one of the great vital issues which have been forced upon modern theology and made prominent by the later advances of scientific thought. His subject is the relations of religion to civilization and to education.

President Seelye's argument has been interpreted as an assault upon the doctrine of evolution, and by his admirers as an annihilation of it. The *Christian Intelligencer*, for example, says, "It has fallen like a bomb into the camps of skepticism;" and has a startling significance "in this day of theological enervation and cowardice before a dogmatic evolutionism." Again, the writer says: "He first of all joins issue with the superficial and unsupported notion that there is 'an inherent law of progress in human nature by which it is constantly seeking and gaining for itself an improved condition,' and contends, on the contrary, that there is a 'law of deterioration.' Most acutely and eloquently does he prick this bubble, blown of sentimentalism and conceit, which has so long been suffered to pass unchallenged, and even been hastily adopted by Christian thinkers."

Now, with this estimate of the address we can hardly agree. If evolutionism be a bubble, we doubt if it has been reserved for President Seelye to prick it; and if the address be a bombshell, there are grounds for thinking that it is the president's own party that must beware of the explosion. His positions are: 1. That the historic phenomena of national decay disprove the doctrine of evolution; 2. That whatever progress there has been is due to the supernatural. He says:

> "No historical fact is clearer than that human progress has never revealed any inherent power of self-perpetuation. Arts, languages, literature, sciences, civilizations, religions, have in unnumbered instances deteriorated and left a people to grope in the shadow of death whose progenitors seem to rejoice in the light of life."

Again:

> "It was not the construction of his house that taught man to build his temple, but exactly the other way. The same is true with sculpture, painting, poetry, and music. It was a religious impulse which gave to all these their first inspiration. The oldest monuments we possess of any of these arts are associated with some religious rite or faith. But, more than this, we must also notice the undoubted fact that the arts have grown in glory just as the religious sentiment has grown in power."

In brief—

> "The supernatural is the Alpha as well as the Omega of human thought."

These are favorite ideas with President Seelye, which he has expounded elsewhere, and we shall perhaps get his view more sharply before us by quoting briefly from an earlier statement, also made with deliberate care. In the article on "Darwinism," in "Johnson's New Universal Cyclopædia," he says:

> "The history of men is full of instances of deterioration. If we weigh it simply by number, whether of years, or of nations, or of individuals, degeneration and decay vastly preponderate. Where is the civilization now of Tyre, and Carthage, and Babylon, and Nineveh? and where are the arts which built the Great Pyramid and Baalbec? All over the world we have evidence of a tendency among nations and men to sink away from civilization into barbarism, but history

does not show an instance of a nation rising by its own efforts from barbarism to civilization. . . . The incontestable fact is, that human nature reveals no inherent impulse to improve or perfect itself. History gives unnumbered cases of a downward tendency, but not a single instance of a self-evolved progress. The lamp which lights one nation in its advancement has been always lighted by a lamp behind it. Civilization is never indigenous; it is an exotic plant wherever found. This is the simple truth of history, which makes all such discussions as Mr. Darwin's respecting the descent of man as false to fact as they are abhorrent to philosophy."

President Seelye's inference that because nations decay there is no evolution of humanity, does not appear to be conclusive. The considerations alleged as making the doctrine of Darwin's discussions "false to fact" seem to us to be in harmony with it, and the natural consequence of it. President Seelye appeals to the historic phenomena of deterioration, disintegration, and decay among nations and civilizations as disproving the principle of development; but how is decay made possible except by previous growth, and how can a community degenerate unless it has first been organized and unfolded? The conclusion is certainly logical that before civilizations can dissolve they must first be evolved, so that to affirm a "law of deterioration" is necessarily to imply a previous "law of evolution." In the normal course of Nature the effete and outworn must pass away. The spent molecules of our tissues have to be eliminated, that more vitalized particles may replace them. Individuals when they get old and useless die out of the community, that their younger and more vigorous successors may carry on the work. On the larger scale, but in the same way, nations die out as civilization progresses; while civilizations themselves are spent in the larger advancement of humanity. We may brood with morbid sentiment over excretion, decay, and death, until there seems to be nothing else; yet these are normal things, and are simply the correlates and the consequences of growth and life. President Seelye declares that in the past career of humanity "degeneration and decay vastly preponderate;" he should have explained how that can be —how there could be a fall without a previous rise to make it possible. If he means that much the greater number of nations and civilizations come apparently to naught, we have simply to say that this is the law in the realm of life: the eggs that are wasted and the seeds that are scattered and lost vastly preponderate over those that mature. Nature is profuse in the waste of life, and sacrifices multitudes where but few are perfected. But is not this ruthless and wide-spread destruction only a part of Nature's policy for the attainment of grand results? The evolutionists affirm continuity of influence in the sphere of life, and that some of the nations and civilizations which decline and die pass on the impulses which they have gained to reappear in succeeding and higher stages of national and racial development. President Seelye recognizes this principle of continuity in saying, "The lamp which lights one nation in its advancement has been always lighted by a lamp behind it." National advancement is here conceded, and also a series of advancements, each depending upon a preceding one. But is there nothing gained by accumulated experience? Is there no general progress resulting from the advancement of nations in succession and under different circumstances? If the dissolution of states and the decay of civilizations do not break the continuity of those agencies by which man is civilized, how can they hinder that gradual improvement of the process and heightening of the effects which evolution implies as the consequence of prolonged, varied, and accumulated national experiences?

If we try President Seelye's logic in a more special case, its quality will, perhaps, be more apparent. "Behold,"

he might say, "the orchards of the world! They deteriorate and decay, and nothing remains of them at last but withered branches, dead trunks, and rotten stumps. Where are the orchards mentioned by Pliny, the orchards of the middle ages, the old Indian orchards, or even the orchards of the Revolution? The history of apples does not show an instance of an orchard growing by its own efforts. The vitality which impels one orchard in its growth has always been kindled from the vitality of an orchard behind it. This is the simple truth of history, which makes all such discussions as Mr. Darwin's respecting the descent of the golden pippin from the sour and miserable crab as false to fact as they are abhorrent to pomology."

In regard to the second and main position of President Seelye's address respecting the relations of religion to civilization, it is chiefly interesting from the indications it affords of the rationalistic tendencies of New England orthodoxy. We by no means object to the prominent part which he assigns to religion in promoting the progress of man; and are only agreeably surprised at the catholicity of his position. The president says that "human nature reveals no internal impulse to improve and perfect itself;" this he maintains is due to an external impulse, to a power above man, which he assumes to be the agency of supernatural religion. But the transition from barbarism to civilization has taken place on an extensive scale. President Seelye asks, "Where are now the civilizations of Tyre and Carthage, of Nineveh and Babylon?" His question implies that they once existed, and his hypothesis of their origin is that they were the product of religious inspiration and supernatural agency. It will be hardly claimed that those ancient and extinct civilizations were due to the Christian religion; but if not, then they were caused by other religions potent with genuine inspirations and supernatural in their elevating influence. Yet is it not the essence of orthodoxy that it is the only true faith, and that all other so-called religions are delusions, impostures, and heathenish superstitions? The implication of the inaugural address contravenes evangelical theology by assuming that there are other religions than that professed in New England, which are genuinely attested as of supernatural influence by their civilizing impulses, and which have been in operation whenever and wherever there has been any improvement in the condition of humanity. Now, this recognition of the universality of genuine religious influences, as opposed to the exclusive claims of any particular system, we understand to be the broad ground of rationalism; and, if Amherst orthodoxy can accept it, we shall certainly be the last to complain. We only hope, however, that this surrender, horse, foot, and dragoons, to ultra-rationalism, is not to be considered as a bomb-shell in the camp of evolution.

It is a serious question whether President Seelye has not here put a strain upon the claims of supernaturalism which endangers them. Granting the universality of the religious agency, he must explain why it is not always efficient in the work of elevation. The president points impressively to the phenomena of national degeneracy and decay. Viewed as a part of the order of Nature, these phenomena are explicable; but, from President Seelye's point of view, what reason is there why all that had been gained should be thus thrown away? His theory that true religious influences are coextensive with all phases of human progress is an important step in the liberal direction; and his further assumption that the rhythmic successions of progress are due to an intermittent supernaturalism can have little other tendency than to eliminate the supernatural from the investigation of the subject. Why should President Seelye

stop half-way, and, having taken latitudinarian ground in regard to the extent of true religious influences, why should he not complete the work of rationalization by recognizing the religious element as a necessary and indestructible part of the constitution of human nature?

The question of the agencies by which man has been civilized or failed to become so, and which determine his present advancement or retrogression, involves forces which do not belong to an imaginary sphere of mystical caprice, but to the orderly course of natural things which it is the proper office of Science to explore. The religious agency must submit to this ordeal, and be dispassionately studied in its laws of action in connection with and in the same way as all the other agencies which enter into the great result, and which are just as divinely ordained as that to which theologians are wont to ascribe everything, and of which they claim to be the special guardians. President Seelye rechoes the old assumption, although in a manner which shows how far his law of decay has already taken effect upon orthodoxy under the liberalizing influence of Science. But if the reader desires to obtain a better idea of the progress that the scientific method has really made in its application to the study of civilization, and to contrast its results with those of preceding methods, let him carefully read the opening article of the magazine in his hand.

LITERARY NOTICES.

NOMISMA; OR, LEGAL TENDER. By HENRI CERNUSCHI. New York: D. Appleton & Co. Price, $1.25.

THIS book contains the testimony given by M. Cernuschi, the well-known French bimetallist, before the United States Monetary Commission in February last, together with several of his essays reprinted from other sources. Although the work of an ardent advocate of a double standard, defending his views with ability, the book is not one which would afford much comfort to the silver party of this country. We commend it to them for perusal; they will find well stated the extent of the mischief which would come from the adoption of the double standard by the United States, unless a similar step be taken by all commercial nations. From it also the greenback-men might learn that a prime essential of good money is that its issue be an automatic issue which no one can control—something independent of human agency—and this, of course, is an attribute that paper-money can never possess. As to the merits of a bi-metallic system, if it could be made universal—if the same ratio between gold and silver, and the same mint laws, could be established the world over—it is a question upon which a great deal is to be said on both sides, and certainly M. Cernuschi puts his side of the case very strongly. But we cannot help thinking that, practically, it is of about as much importance to us as a question of lunar politics. The prospect of England, for example, abandoning the single gold standard is too remote for this phase of the question to be taken into present account. It is an interesting economic speculation, and nothing more.

It may be added that M. Cernuschi proposes to make silver just as good as gold for all purposes of money; worth just as much. He has, therefore, little in common with our silver-men: they would cease to care about the "dollar of our fathers" if it were made as good as gold; they want it only because it is worth less, and can be made the means of forcing a composition upon their creditors at something less than one hundred cents.

SCIENTIFIC BASIS OF DELUSIONS. By G. M. BEARD, M. D. Pp. 47. New York: Putnam's Sons. Price, 50 cents.

THE author, in the introduction to this little work, tells us that it is preliminary to a "work on the Philosophy of Delusions, which will aim to unfold in detail the phenomena of the Involuntary Life, including Trance, and to give practical suggestions for the reconstruction of the principles of evidence in their application to history and

to logic—to science and to law." In the present volume he proposes a new theory of trance, and considers its bearings on human testimony. Trance—whether natural as somnambulism, or self-produced as by so-called "trance-speakers"—results from activity of a portion of the brain-substance while the remainder sleeps: this is the "Involuntary Life." In this state men see visions, receive revelations, and have ecstasies, after the manner of Mohammed, the mediæval saints, and Swedenborg.

ORIENTAL RELIGIONS AND THEIR RELATIONS TO UNIVERSAL RELIGION.—CHINA. By SAMUEL JOHNSON. Boston: Osgood & Co. Pp. 975. Price, $5.

THE author of this work is an Oriental scholar of fine accomplishments, and a philosophical student of theology in a very broad and liberal sense. He is a transcendentalist, and like Emerson and Ripley he formerly preached, but like those worthies he outgrew the function of pulpit teacher, but only to devote himself more assiduously to the pen. Starting with the religious problem of humanity, and treating it with the freedom and boldness of the transcendentalist, Mr. Johnson was soon carried beyond the narrow boundaries of the faith he had inherited, and was powerfully drawn to the consideration of those ancient religions of the East which are celebrated alike for their antiquity, the vast multitudes of their believers, and the philosophical interest of their doctrines and dogmas. This line of inquiry had such fascination for Mr. Johnson, and seemed so full of promise as a source of enlargement and a more catholic spirit to Christian thinkers, that he resolved, twenty years ago, to devote himself to the exposition of the Oriental faiths in connection with the life of the Eastern peoples, for the advantage of English readers.

In 1872 he published the first volume of this research on the "Faiths, Religions, Philosophy, and Life of India," as a contribution to the natural history of religion. His point of view was rational and scientific, and he delineated the characteristics of the Hindoo mind, its traditions and social forms, its piety and morality, and the speculative principles, ethics, and humanities of Buddhism, with a deep sympathy for the human elements involved, but with the same disciplined coolness of temper with which Herschel explored the heavens, and Lyell investigated the crust of the earth. "I have written," he says, "not as the advocate of Christianity or any other distinctive religion, but as attracted on the one hand by the identity of the religious sentiment under all its great historic forms, and on the other by the movement indicated in their diversities and contrasts toward a higher plane of unity on which their exclusive claims shall disappear."

The second volume in the same line of study now appears, and is devoted to China. This is especially opportune, now that we have the Chinese problem upon us in so imminent a form on the Pacific coast. The Californians will deal with it in the light of race-prejudice, and in its passionate and sordid aspects; but the intelligent mind of the country will desire to inform itself regarding the real character of this extraordinary people. To all who are thus inclined Mr. Johnson's volume will be full of grave instruction. It is not a mere superficial delineation of Chinese life, such as a traveler would give us who had been impressed by its sensuous aspects, but it is an analysis of the Chinese mind, an ethnic study, and the survey of a civilization. Education, government, language, literature, history, and poetry, are taken up systematically in the division of "structures," and an immense amount of most important information is here compactly presented. It is of but little use to talk to Americans about education anywhere else in the world; yet, as we are rapidly sliding into the Chinese system of education by state control, our people might profitably look into the working of that system where it has had prolonged trial and worked out its legitimate consequences.

Mr. Johnson has not failed to point an incidental moral in this direction. He says: "Chu-tsze defines learning as imitation—conformity to a prescribed standard; and in these schools even organization holds an inferior place to the mere act of 'repeating after the teacher, each by himself, in a shrill voice, rocking to and fro.' This perfect image of automatism is not without resemblance to the arrangements into graded

classes, so much admired in our Western school systems, and to those arts of 'reading in concert' which are believed to have such virtue in our democratic culture.

"It would in fact be difficult to imagine a better outward symbol of the mental status produced by these processes of an excessive organization, so widely admired in the public schools of America. They tend to destroy all possibility of original force. Reading, for instance, is becoming reduced to as purely mechanical a conformity to prescribed tone, time, and emphasis, as the Chinese custom of repeating words after the teacher has produced without any organization whatever. Chinese boys, rocking out their parrot tones, eagerly copying the master, or 'backing the books,' do but openly confess, in their noisy routine of imitation, the mental slavery which our prevailing system disguises under the varnish of a 'drill.' 'Reading in concert' has played its part in the Chinese system also, with effects upon voice and manner which we need not cross the hemisphere to find in full operation.

"Concerning 'imitation' as a principle of culture, let us add that, false as it is, its moral quality at least is higher when it follows, as in China, a type that does not change with human caprice, than when it is subject to arbitrary crudities and idiosyncrasies imposed on the pupils by individual teachers. In both cases, however, the real ultimate reference is to an all-powerful authority in that public sentiment and common belief of which these educational systems are meant to be the expression. And when this *public control* has become all-pervading, as it steadily tends to be, whether as Chinese tradition of ages, or American fashion of the hour, its effect through *imitation*, in leveling and trimming young minds into a dull, self-satisfied uniformity, is indisputable. In the course of ages it has cast all Chinamen in one mould, and made their intellectual productions as monotonous as their physical type. The warning is for us, even at the opposite pole of social and political character."

Of moral education the author says: "More prominent than rote-work in the programme of the school system is respect for moral laws as eternal and divine. Modesty and humility; reverence for the old; the evil of war and the wickedness of cruelty and conquest; the love of truth, purity, and self-restraint; delicacy of feeling, devotion to duties, fidelity to functions—are the burden of this popular teaching, the very substance of text and precept. I believe, not only that the whole series of reading-books used in the schools of China does not contain a single impure precept, but that there is scarcely one noble conception of duty and humanity that cannot be found represented in the daily recitations of these children of a grand ethical literature, who are taught to prize it, not with slavish superstition, but for the naturalness of its ideal. Nor does this textual teaching fail of a practical basis in the home. It would be difficult to find any treatise on home education more admirable than the 'Instructions of the Sacred Edict,' whose utilitarian wisdom is here overflowed by tenderest sentiment."

In regard to Chinese education in manners, Mr. Johnson remarks: "As the moral relations are expressed in a concrete ideal, in which no change is supposed possible, so they are embodied in rites and ceremonies which share their sacredness. As the child learns ideas in the form of actual written characters, so he conceives duties in the form of strictly-regulated actions. Hence the prime importance of the 'proprieties' in education. They are not affectations, but recognized as the natural order of conduct, the virtue of behavior. . . . The authority of fixed rules of behavior, while scarcely more absolute than that of fashion in Western society, is not, like fashion, detached from the highest law of ethics and faith, but is strictly identical with it. To the Chinese, their ceremonial is simply man in his manifold relations. Its minute rules, which appear to exhaust the possibilities of prescription, are believed to express man's normal relations to the universe. They seem, in fact, to have historically grown out of the national consciousness of these relations, instead of being imposed by arbitrary authority or transient will. What they correspond with in Western life is not our etiquette, red tape, or religious formalism, but such conformities as are admitted by all of us to be natural, proper to all right

performance of functions, and therefore of highest import. These conformities would of course differ from those of the Chinese, being based on more complex relations and wider knowledge of Nature, and hence more open to changes of detail; but their ethical ground is really the same. Thus the minute ritual of Chinese filial piety consists in routines of conduct which are recognized as beyond all question the best, and indeed the only, ways in which an ideal love and reverence can be fulfilled. It is sufficiently clear, from the spirit of these prescriptions, that this minuteness itself is simply an endeavor to inspire the whole of domestic life with real reverence and love."

After a broad sketch of the Chinese character and quality, Mr. Johnson passes to a study of the Chinese sages, their doctrines and influence, and the national beliefs on religious subjects, the development of Chinese Buddhism, missionary experiences, and closes his work by a presentation of the philosophy, metaphysics, and anthropology, that prevail in China. We cannot here even attempt to give the author's conclusions upon many important topics which he considers, and will only say that while he evidently has great respect for much that is to be found in the institutions and ideas of this great division of the Oriental world, he is by no means an undiscriminating admirer of everything Chinese. Of course they are benighted heathen, and we send missionaries to instruct them in better religious ways. This attitude, however, is not altogether favorable to a just judgment of the Chinese character, and Mr. Johnson has done an excellent service in correcting our prejudices and giving us truer views of the faith and life of so large a portion of the human family.

A Hand-book of Descriptive Astronomy. By George F. Chambers, F. R. A. S., of the Inner Temple, Barrister-at-Law. New York: Macmillan & Co. Pp. 938. Price, $10.

This is in all respects a most excellent book on astronomy, clear, full, splendidly illustrated, carefully accurate, and in a high degree popular. The first edition was issued ten years ago, and a third being now called for, the author has thoroughly revised it and added two hundred pages of new matter, bringing it sharply up to the time. His reason for making the book is thus stated: "There is a lack of works in the English language which are at one and the same time attractive to the general reader, serviceable to the student, and handy, for purposes of reference, to the professional astronomer; in fact, of works which are popular without being vapid, and scientific without being unduly technical." In regard to the present edition Mr. Chambers says: "There is scarcely a single page which has not been to a greater or less extent dressed up, or in some way amended, with the object of making its statements more accurate in substance or intelligible in diction. The most important changes will be found in the chapters dealing with the sun, sidereal astronomy, and astronomical instruments. The descriptions of clusters and nebulæ have been made more numerous, and the lists of objects critically revised one by one actually at the telescope, so as to make that portion of the work more completely than formerly a *vade mecum* for the mere star-gazer, who is an astronomer simply in the respect that he is the owner of a telescope. Indeed, it has been chiefly with this idea in view that so much additional matter has been introduced into the chapters relating to astronomical instruments. The 'Practical Hints' and suggestions have been gathered from so many sources, and embody the collective wisdom and experience of so many men, that they cannot fail to deserve attention. I believe also that this volume now stands alone in its full description, so far as regards the wants of amateur observers, of the mounting and use of reflecting telescopes."

List of Elevations, principally in that Portion of the United States west of the Mississippi. By H. Gannett, M. E. Washington: Government Printing-Office. Pp. 164.

This fourth edition of the work named above embodies the results of its author's continued labors down to 1877. It contains profiles of nearly all the railroads in the region west of the Mississippi; elevations of many thousands of points; mean heights of the States and Territories; slopes of the principal streams in the West, etc. A map of the United States, in approximate

contours of 1,000 feet of vertical intervals, and embodying all the results of the author's researches on elevations, accompanies the work. We are informed that, "to express still more clearly the facts brought out by the map, it is the intention of the Survey (Hayden's) to make shortly a relief model of the United States on the basis of this map."

INFLUENCE OF PHYSICAL CONDITIONS IN THE GENESIS OF SPECIES. By J. A. ALLEN. (From the *Radical Review*.) Pp. 33.

MR. ALLEN, in enforcing his thesis that the "conditions of environment" are the principal factors in modifying species, adduces some very instructive examples of the progressive enlargement of certain peripheral parts of animals as we go from the north to the south. Thus the ears of wolves, foxes, some deer, and hares, are larger in southern than in northern individuals of the same species. In birds, the enlargement of the bill, claws, and tail, is specially noticeable—the bill being peculiarly susceptible of variation. This, the author remarks, accords with the general fact that "all the ornithic types in which the bill is remarkably enlarged occur in the intertropical regions." A similar progressive change southward is remarked in the color of animals, especially birds.

THE GEOLOGY OF THE EASTERN PORTION OF THE UINTAH MOUNTAINS. By J. W. POWELL. Washington: Government Printing-Office. Pp. 217.

THE region described in this report by Prof. Powell comprises three great geological provinces, designated respectively the Park Province, the Plateau Province, and the Basin Province, succeeding one another in this order from east to west, and all lying east of the Sierra Nevada and west of the great Plains. The whole region is one of considerable geological interest, as presenting on a large scale three great categories of facts, namely, those relating to displacement, degradation, and sedimentation. The formations here studied have an aggregate thickness of 50,000 feet, and embrace strata of the Palæozoic, the Mesozoic, and the Cenozoic ages. The volume is fully illustrated with plates and woodcuts, and accompanied by an atlas of colored maps.

GEOGRAPHICAL SURVEYS WEST OF THE ONE-HUNDREDTH MERIDIAN. By Lieutenant G. M. WHEELER. Pp. 355. With Illustrations. Washington: Government Printing-Office.

DURING the year ending June, 1876, Lieutenant Wheeler's Survey was organized in two divisions, designed to operate, the one in California, and the other in Colorado and New Mexico. The volume before us, besides the general report of Lieutenant Wheeler, and the executive and descriptive reports of the officers in charge of the California and Colorado divisions, contains several special reports by scientific men attached to the survey, among which we may mention, as possessing a direct popular interest, reports by Dr. Loew on alkaline lakes and mineral springs in Southern California, and on the physical and agricultural features of the same region; a report by Dr. Yarrow on ethnological researches made near Santa Barbara; an analysis by A. S. Gatschet of eleven Indian dialects; last, but by no means least, Lieutenant Bergland's report on the operations of a party commissioned to determine the feasibility of diverting the Colorado River for purposes of irrigation.

PRECURSORY NOTES ON AMERICAN INSECTIVOROUS MAMMALS. By Dr. ELLIOTT COUES. (From Hayden's "Reports.") Pp. 22. Washington: Government Printing-Office.

THE insectivorous mammals here described belong to two families, namely: *Talpidæ*, or moles, and *Soricidæ*, or shrews. Of moles the author recognizes four good genera as existing in America, namely: *Scalops*, *Scapanus*, *Condylura*, and *Urotrichus*. *Urotrichus* is the only one of the four known to be common to both hemispheres. Of European genera of *Soricidæ* only one, *Sorex*, is known to occur in America; *Blarina* is the most characteristic American genus. The third and last of the American genera is *Neosorex*.

REPORT OF THE PHILADELPHIA BOARD OF HEALTH FOR THE YEAR 1875. Pp. 351.

WE have specially to commend this volume for the many neat graphic charts which it contains. Statistical tables are always dry and confusing, but when they are cast

into the shape of graphic charts even the most careless cannot fail to note the fluctuations of the quantities which they represent. Among the matters treated of in the body of the report, we would name especially the Municipal Hospital, water-supply, nuisances, as fat-boiling, intramural interments, etc. The deaths in Philadelphia for the year covered by the report numbered 17,805, an increase of 2,567 over the preceding year. The exhibit of the statistics of mortality among children under ten was less favorable than usual; the year 1872, when small-pox committed such ravages, was not as fatal to children as 1875. Diphtheria prevailed to an extent unprecedented in the records of the preceding sixteen years.

COÖRDINATE SURVEYING. By H. F. WALLING, C.E. Pp. 19. With Plates. (From "Proceedings of the American Society of Civil Engineers.")

THE object of this essay is best stated in the words of the author himself, who says: "It is the object of this paper to point out a simple method by which the high degree of precision which accompanies the Coast Survey work may be made available in the ordinary operations of land-surveyors and civil engineers, in those districts over which the Coast Survey triangulations have been carried, and at the same time to call attention to the importance of an extension of these triangulations over the entire country."

PROBLEM OF PROBLEMS.

WE noticed, not long ago, a book entitled the "Problem of Problems," a discussion of atheism, Darwinism, and theism, which has been much praised by theological authorities as an annihilating criticism of Evolution and the Darwinian school. The book received some damaging criticism, and the rumor got started that it would be revised. But it seems this is an error. Whatever else may change in this world of mutations, the "Problem of Problems" and its solution in President Braden's book will remain unchanged. The author announces in the Cincinnati *Christian Standard* that "it will never be revised." He says, "The commendations of the book have been such, and by such persons, that it would be a reflection on them to revise it." It is a great satisfaction to have something at last that will be stuck to and can be depended upon. And, now that we have something that is to stand like a lighthouse amid the storms of controversy, it is well to be fully aware of its value, and we notice that the *Journal of Speculative Philosophy*, in its April issue, testifies of the author that "for tilting against the Darwinians, Spencerians, Comtians, Correlationists, Evolutionists, *et id genus omne*, he is well enough accoutred, and is mighty in his cause." We shall do well not to forget how this puissant finality in modern polemics originated. The *Journal* says of the author, "At the age of fourteen he became a skeptic, and lectured in public on the skeptical side of the question." The precocious rogue pursued this scandalous course for ten years, when he was abruptly pulled up, and took the back track. The *Journal* says, "At the age of twenty-four he met a preacher, who converted him, and he began his career as a lecturer against skepticism, the fruits of which are contained in the volume before us." Now, if anybody wants to stop a great scientific movement, he will know how to prepare for it.

WHY THE EARTH'S CHEMISTRY IS AS IT IS. By J. N. LOCKYER, F. R. S. L. New York: Macmillan. Pp. 59. Price 25 cents.

THREE lectures by Mr. Lockyer are contained in this volume; they were originally delivered at Manchester, before a popular audience. In the first of these the author gives a singularly clear account of the principles and main results of spectrum analysis of nebulæ and comets. The second lecture treats of meteorites, and the chemical constitution of the stars and the sun. The third lecture treats of the planets of our system and their atmospheres, and concludes with an exposition of the theory of evolution.

THE TAILED AMPHIBIANS, INCLUDING THE CÆCILIANS. By W. H. SMITH. Detroit: *Herald* print. Pp. 158.

THIS monograph, prepared as a thesis to be presented to the Faculty of Michigan University for the degree of Ph. D., very succinctly describes the distinguishing char-

acters of the several orders of animals belonging to the class *Amphibia*. Wherever the author had it in his power to study the characters of the animals he describes, either in living specimens or in natural history collections, he has done so; in other cases he has had recourse to the writings of the best authors. The work is one of solid merit, both for its original research and for its concise presentation of the results of prior investigation.

PRINCIPAL CHARACTERS OF THE CORYPHODONTIDÆ; CHARACTERS OF THE ODONTORNITHES; NOTICE OF A NEW AND GIGANTIC DINOSAUR. By Prof. O. C. MARSH. Pp. 6. With Plates. (From *American Journal of Science and Arts.*)

A SPECIAL interest attaches to the genus *Coryphodon*, inasmuch as it occurs in the tertiary strata of both hemispheres. In the second paper named above, Prof. Marsh gives certain characters common to the odontornithes with the ostrich. The third paper contains measurements of portions of a dinosaur which surpassed in magnitude any land-animal hitherto discovered, its length having been probably from fifty to sixty feet!

TOPOGRAPHICAL ATLAS SHEETS.

THESE "Atlas Sheets" are a portion of a series of maps designed to embrace the territory of the United States west of the one-hundredth meridian. The present set, seven in number, are devoted to the topography of portions of Colorado, Arizona, and New Mexico. They are based on the results obtained by Wheeler's Survey.

IRON AND STEEL CONSTRUCTIONS. By J. J WEYRAUCH, Ph. D. Pp. 112. With Plates. New York: Van Nostrand. Price, $1.

THE problems discussed in this little volume, namely, the strength and calculation of dimensions of iron and steel constructions, have for some time engaged the attention of engineers on both sides of the Atlantic. The author presents a general view of the results so far obtained, and offers formulas of his own based on Wöhler's law. The calculations have special reference to bridge and building constructions.

GOLD AND DEBT. An American Hand-Book of Finance. By W. L. FAWCETT. Chicago: S. C. Griggs & Co. Price, $1.75.

CONSIDERABLE useful information, and a number of tables convenient for reference, have been gotten together in this book. The money units of the world, paper, coin, suspension of specie payments, etc., are the subjects of a series of chapters which show that the author has bestowed a good deal of labor on them. He says, however, that "the first object was the compilation in compact form, convenient for reference, of trustworthy statements and figures regarding the great factors in the financial problems of the day." There is certainly a need for such a book, but this volume hardly supplies it. The discussion of subjects too large for his space, and of others that are purely speculative, has taken up time and room that should have been used in collecting and arranging the material proper for a hand-book. Thirty-one pages, for example, are given to estimates of the amounts of gold and silver in the world—a sort of speculation that is wholly worthless. There is a lack of system in the arrangement of the tables; there are unnecessary repetitions and unaccountable omissions; and, finally, there is no index, a negligence not to be forgiven in a work of this kind. Still, it will be found convenient for the business-man and the student until a better one is prepared, which, as this is not a very remunerative field of work, may be a long time.

ORNITHOLOGY OF THE REGION ABOUT THE SOURCES OF THE RED RIVER OF TEXAS. By Lieutenant C. A. H. MCCAULEY. (From Hayden's "Reports.") Pp. 40. Washington: Government Printing-Office.

LIEUTENANT MCCAULEY, while on sick-leave in Southern New Mexico, attached himself as a volunteer to an exploring expedition conducted by Lieutenant Ruffner, of the Engineers. His duties mainly related to the survey proper, and he was able to devote to the collection of ornithological specimens only the leisure time left after the day's work or the day's march was over. Nevertheless, he has made a substantial contribution to the avi-fauna of the region explored. The report is edited and annotated by Dr. Elliott Coues, United States Army.

PUBLICATIONS RECEIVED.

Supplemental Remarks on the Physiological Effects of Severe and Protracted Muscular Exercise, with Especial Reference to its Influence upon the Excretion of Nitrogen. By Prof. Austin Flint, Jr., M. D. From the *Journal of Anatomy and Physiology*. Pp. 9.

Some Remarkable Gravel-Ridges in the Merrimack Valley. By Geo. F. Wright. From Proceedings of the Boston Society of Natural History. Pp. 17. Maps 3.

Report on Dermatology. By L. P. Yandell, Jr., M. D. From the *American Practitioner* for June, 1877. Louisville, Ky. Pp. 8.

A New Test-Reaction for Zinc, and other Laboratory Notes. Pp. 6. And Notes upon the Lithology of the Adirondacks. Pp. 35. By Albert R. Leeds. From the *American Chemist* for March, 1877.

On the Production and Use of Compressed Air in Mining Operations. By M. F. L. Cornet. Translated from the French by Robert Zahner. From the *Journal of the Franklin Institute*, for June and July, 1877. Pp. 21.

On the Brains of some Fish-like Vertebrates; on the Serrated Appendages of the Throat of Amia; on the Tail of Amia. By Burt G. Wilder, M. D. From Proceedings of the American Association for the Advancement of Science, 1876. Pp. 11, and Plate.

The Scientist's Theology. By E. A. Beaman. New York: E. H. Swinney, 1877. Pp. 24. Price, 10 cents.

On the Use of Large Probes in the Treatment of Strictures of the Nasal Duct. By Samuel Theobald, M. D. From the Transactions of the Medical and Chirurgical Faculty of Maryland. Baltimore, 1877. Pp. 22.

Report of the Director of the Central Park Menagerie, for 1876. New York, 1877. Pp. 34.

Facts and Figures for Mathematicians; or, The Geometrical Problem which Benson's Geometry alone can solve. By Lawrence S. Benson. New York: 149 Grand St. Pp. 22. Price, 30 cents.

On the Possibility of Transit Observations, without Personal Error. By S. P. Langley. From *American Journal of Science and Arts*, July, 1877. Pp. 6.

Report on the Discovery of Supposed Paleolithic Implements, from the Glacial Drift in the Valley of the Delaware River, near Trenton, N. J. By Charles C. Abbott, M. D. Cambridge, 1877. From Tenth Annual Report of the Peabody Museum. Pp. 14. Illustrated.

Address delivered by Hon. A. J. Peeler, before the State Agricultural and Mechanical College of Texas, June 26, 1877. Austin. Pp. 34.

The Pneumatic Electric System for lighting and extinguishing the Gas used for Street-Lights, and the Use of the Apparatus for General Telegraphic Purposes. By John H. Blake. Boston, 1877. Pp. 33. Illustrated.

The National Guardsman. A Journal devoted to the Interests of the National Guard of the United States. Vol. I., No. 1. August, 1877. Monthly. Pp. 16. Price, $1 a year.

Thirty-third Annual Catalogue of the Officers, Faculty, and Students, of the University of Notre Dame, Indiana, for the Academic Year 1876–'77. Pp. 62.

Remarks of Robert E. C. Stearns on the Death of Colonel Ezekiel Jewett; and also on the Late Dr. Philip P. Carpenter. Before the California Academy of Sciences. Pp. 5, each.

The Magnetism of Iron Vessels, with a Short Treatise on Terrestrial Magnetism. By Fairman Rogers. New York: D. Van Nostrand, 1877. Pp. 125. Price, 50 cents.

Art-Education applied to Industry. By George Ward Nichols. With Illustrations. New York: Harper & Brothers, 1877. Pp. 211. Price, $4.

The American Palæozoic Fossils. A Catalogue of the Genera and Species, etc. By S. A. Miller. Cincinnati, 1877. Pp. 253. Price, $3.

Mesmerism, Spiritualism, etc. By William B. Carpenter, LL. D., F. R. S. New York: D. Appleton & Co., 1877. Pp. 158. Price, $1.25.

The Question of Rest for Women during Menstruation. By Mary Putnam-Jacobi, M. D. The Boylston Prize Essay of Harvard University for 1876. Illustrated. New York: G. P. Putnam's Sons, 1877. Pp. 232. Price, $3.50.

POPULAR MISCELLANY.

Death of Prof. Sanborn Tenney.—We have learned with regret of the death of Prof. Tenney, which took place on July 9th, at Buchanan, Michigan. The sad event was unexpected, as the deceased had, one week previously, seemed to enjoy perfect health. The cause of death is supposed to have been heart-disease. From an appreciative biographical sketch of the deceased which has appeared in the *New York World* we gather the following particulars about his scientific labors: In 1868 he was Professor of Natural History in Vassar College, and in the same year accepted a like position in Williams College. He had already published an elementary text-book of geology, which is still, after repeated revisions, largely used in high-schools and academies. He was a frequent contributor to periodical literature of scientific articles of a popular kind. The present number of the MONTHLY contains probably the latest essay of this description written by him. He was an enthusiastic and careful student, a pupil and admirer of Agassiz, and like his distinguished preceptor he excelled as a teacher. Besides the "Geology" mentioned above, Prof. Tenney compiled several other popular text-books, among them one on zoölogy. He occupied the chair of Natural History in Williams College down to the time of his death. He was to have been in charge of an expedition of college-students to the far West this season, and on the day he died was to have joined the expedition at Chicago.

Remains that were not prehistoric.—We have received from a source unknown to us two clippings, from the *Weekly Press*, presumably of Santa Barbara, California, in

which mention is made of the result of excavations in "the Carpenteria." These excavations led to the discovery of a large mass of human bones, domestic implements, trinkets, and other objects, which were at first supposed to be "prehistoric." The ardor of the explorers was, however, much dampened when they found among the treasure-trove such modern articles as glass beads and glass wine-bottles, and the conclusion was inevitable that the curiosity-seekers had simply struck "a big graveyard of the native population, whom the missionary *padres* found and taught here eighty or one hundred years ago." A letter of inquiry having been addressed to Mr. Hubert H. Bancroft, author of "The Native Races of the Pacific States," that gentleman expressed in the following terms his opinion of the supposed prehistoric character of the Carpenteria "find:"

"There is no evidence whatever in California of a race older or more civilized than that found by Europeans a century or so ago. In Mexico and Central America the case is very different. There are a few material remains in Northern Mexico, Arizona, and New Mexico, but nothing, so far as I have been able to discover, north of these points."

Rare Minerals in Colorado.—Writing of rare minerals found in Colorado, Mr. T. F. Van Wagenen, in the *Engineering and Mining Journal*, says that thallium, indium, and cadmium, have lately been detected in ores from that State. Of the rarer metals there have been found in Colorado, besides the three mentioned above, nickel, cobalt, selenium, tellurium, uranium, bismuth, molybdenum, and platinum, and there is scarcely a doubt that columbium, thorium, titanium, and vanadium, will be recognized as soon as proper search is made. A belt of tellureted veins is believed to traverse the entire State from north to south. Two years ago, sylvanite and altaite were found in San Juan County. The principal locality for bismuth-ores is in Geneva, where two mines are being worked that carry a considerable quantity of schirmerite. Sulphide and carbonate of bismuth occur on Sugarloaf Mountain, Boulder County. Nuggets of native bismuth are common in the upper gulches of the Blue Valley; the same metal has been found also in the Arkansas Valley. Nickel-ore, ranging from two to five per cent., has been found in three localities. Among the mineralogical curiosities of the tellurium belt may be mentioned a telluride of mercury found in the Mountain Lion mine. Native mercury and amalgams of both gold and silver have also been found at several points along this belt.

The Vienna Scientific Club.—In January, 1876, the project of founding a Scientific Club in Vienna was considered at a meeting of the Geographical Society of that city. It was very favorably received by the members, and measures were taken to carry it into execution. Before many weeks the club was organized, and suitable quarters provided for it in the house occupied by the Austrian Association of Engineers and Architects. There the club finds ample accommodation for the social gatherings of its members, as also for its regular Thursday-evening meetings for scientific discussion, and its more public entertainments. In March, the number of members was nearly 700, and it was steadily increasing. The yearly dues of members of the club amount to only sixteen florins—less than eight dollars—and there is an entrance-fee of five florins. The club has a growing library and reading-rooms, with a very large number of periodicals, scientific and literary, on file. If such clubs as this, and equally inexpensive, were founded in our large American cities, they would afford a much-needed means of communication between workers in different branches of science. Further, they would give something like organization to the body scientific, and perhaps add weight to scientific opinion.

Steel-Bronze Cannon.—Uchatius's invention of "steel-bronze" cannon rests, says *Nature*, on the observation that all metals (lead and zinc excepted) gain an increase of elasticity, after undergoing a continuous weighting above their first limit of elasticity. Later experiments by the inventor of the steel-bronze cannon appear to show that even homogeneous bronze is capable of a great increase of its elasticity through simple stretching without condensation. It is only a stretching of the metals above

their limit of elasticity, whereby the molecules, brought to a state of flow, glide over each other, and assume a wholly new position more favorable to resistance, that causes the increase of elasticity. A simple condensation produces merely an increase of the absolute solidity and diminution of the tenacity, but no real increase of elasticity. The limit of elasticity may be raised nearly to the breaking consistence, so that, in many cases, it is six and seven times the original. Mere stretching for a short time is of little use; the tension must last a considerable time. It is also well to apply a gradually-increasing weight.

Properties of White Paint.—As the result of hundreds of experiments in carbonate of lead and hydrate of lead, both separately and mixed, Messrs. Wigner and Harland, of the British Society of Public Analysts, reach the conclusion that a white paint, to be efficient, and to possess both the powers of laying on readily and easily, and by its opacity hiding the color beneath, must consist of an admixture of hydrate and carbonate of lead in a certain definite proportion. The true proportion would appear to be three equivalents of carbonate of lead and one equivalent of hydrate. The experiments further show why zinc-white, carbonate of magnesia, and other metallic oxides and carbonates, do not yield good paints. In the case of white-lead a positive chemical compound has been formed, and the seventy-five per cent, or thereabouts, of carbonate of lead present has been dissolved in the chemical compound, and so a paint has been formed which possesses a covering power in excess of any other compound known. Until some means can be devised by which oxide of zinc or some other substance can be dissolved in the same way, so as to form a paint possessing characters somewhat different from a mere emulsion, it is vain to expect that they can equal good white-lead.

Change of Tint in Flowers.—The change of tint in flowers of *Ipomoa purpurea* (morning-glory) under the influence of atmospheric moisture was the subject of a communication by Prof. D. S. Martin to the New York Academy of Sciences. The phenomenon was observed in dark-blue flowers of this plant, and it was found to occur under two aspects, viz., 1. A reddening of the general blue color when the air is charged with moisture; and, 2. The production, by drops of rain, of sharply-defined spots upon the blue, which are at first red, and then bleach to white. Prof. Martin was led to examine the subject experimentally, by testing the flowers with acids and with ammonia-water. The result was such as was to have been expected with vegetable blues, that is to say, the ammonia had no effect, while the solutions of acids (oxalic, tartaric, and carbolic) produced the red coloring easily. Tried upon the pink variety of flowers, the acids had no effect, and the ammonia produced a strong blue color, which ere long passed away by evaporation. It is therefore evident, the author concludes, that this effect is due to some acid substance dissolved or absorbed by atmospheric water. If the latter is diffused through the air without precipitation, a general reddening of the blue corollas appears; if it falls upon them as rain and stands for a while, every drop produces a sharp spot that passes from red to white.

Barff's Method for preserving Iron.—A method proposed by Prof. Barff for preventing the corrosion of iron consists in producing upon the surfaces of the iron articles to be protected a coating of the black or magnetic oxide of iron. This he does by raising the iron articles, in a suitable chamber, to a temperature of from 500° to 1,200° Fahr., and then passing steam into this chamber, keeping the articles for five, six, or seven hours, as the case may be, at that temperature, in an atmosphere of superheated steam. At a temperature of 1,200° Fahr., and under an exposure to superheated steam for six or seven hours, the iron surface becomes so changed that it will stand the action of water, even though it be impregnated with the acid fumes of the laboratory. When the process is carried on at a lower heat, the iron articles will resist any amount of moisture with which they may come in contact in a house or building; but they will not permanently resist the action of the weather out-of-doors. The reason of this is, that only a thin film of the

iron, on its surface, is transformed into the black oxide. Iron pipes protected by this process may be used instead of lead pipes for conveying water through houses. Iron for architectural uses may be made to resist the weather; the process may also be employed to protect cast-iron statues, which would thus be rendered as enduring as those of bronze.

The Mystery of Pain.

BY PROFESSOR GRANT ALLEN.

On the crimson cloth
  Of my study-desk
A lustrous moth
  Poised, statuesque.
Of a waxen mould
  Were its light limbs shaped,
And in scales of gold
  Its body was draped;
While its delicate wings
  Were netted and veined
With silvery strings
  Or golden-grained,
Through whose filmy maze
  In tremulous flight
Danced quivering rays
  Of the gladsome light.

On the desk close by
  A taper burned,
Toward which the eye
  Of the insect turned.
In its vague little mind
  A faint desire
Rose undefined
  For the beautiful fire.
Lightly it spread
  Each silken van,
Then away it sped
  For a moment's span;
And a strange delight
  Lured on its course,
With resistless might,
  Toward the central source,
And it followed the spell
  Through an eddying maze,
Till it staggered and fell
  In the deadly blaze.

Dazzled and stunned
  By the scalding pain,
One moment it swooned,
  Then rose again:
And again the fire
  Drew it on with its charms
To a living pyre
  In its awful arms:
And now it lies
  On the table here
Before my eyes
  All shriveled and sere.

As I sit and muse
  On its fiery fate,
What themes abstruse
  Might I meditate!
For the pangs that thrilled
  Through its delicate frame,
As its senses were filled
  With the scorching flame,
A riddle inclose
  That, living or dead,
In rhyme or in prose,
  No seer has read.
"But a moth," you cry,
  "Is a thing so small!"
Ah, yes, but why
  Should it suffer at all?
Why should a sob
  For the vaguest smart
One moment throb
  Through the tiniest heart?
Why, in the whole
  Wide universe,
Should a single soul
  Feel that primal curse?
Not all the throes
  Of mightiest mind,
Nor the heaviest woes
  Of humankind,
Are of deeper weight
  In the riddle of things
Than this insect's fate
  With the mangled wings.

But if only I,
  In my simple song,
Could tell you the *why*
  Of that one little wrong,
I could tell you more
  Than the deepest page
Of saintliest lore,
  Or of wisest sage:
For never as yet
  In its wordy strife
Could Philosophy get
  At the import of life;
And Theology's saws
  Have still to explain
The inscrutable cause
  For the being of pain:
So I somehow fear
  That, in spite of both,
We are baffled here
  By this one singed moth.

Prof. Hebra on the Use of the Bath.—Prof. Hebra, of Vienna, dissents from the generally-received opinions as to the benefits of frequent resort to the bath. His views on this subject, as set forth at some length in the *Boston Journal of Chemistry*, are to the following effect: It is not true that frequent bathing is conducive to health, and harmless: millions of men take no baths of any kind, at most only washing the face and hands, and yet live to old age in good health. It cannot be proved that

the use of the various kinds of baths wards off disease, or that washing in cold water prevents catarrh, rheumatism, etc. As long as "water manipulation" is accompanied by an agreeable general sensation and no eruption on the surface of the skin occurs, it may be pursued as a pastime; but when it produces great itching or eruption on the skin, the bathing and washing must cease. The consequences of friction, douches, hot vapor, shampooing, etc., sooner or later show themselves in the shape of permanent redness, a sensation of burning or itching, and the production of nodules and furuncles, which precede the formation of pustules and abscesses. Prof. Hebra speaks as follows of the employment of water in the treatment of skin-diseases:

"Its employment is *contraindicated* in all sensitive, irritable persons whose skin is liable to prolonged redness, the production of rashes, and itching; in all cutaneous affections accompanied by acute swelling and serous infiltration; and in all chronic dermatoses in which the horny layer of the epidermis—either through the effects of disease or of remedies—has been removed, exposing the layer beneath. Thus it is not proper to employ water soon after using stimulating substances externally, as arsenic, iodic mercury, etc. By avoiding water and employing starch or other inert powder, the healthy state of the surface will be much sooner restored. Water, on the contrary, is *indicated* in those diseases where its macerating and irritating effects are useful, namely, in chronic dermatoses, such as psoriasis, lichen, ichthyosis, old eczema, prurigo, etc. Water also exerts the most beneficial effects when different secretions—the products of inflammation, and the remains of dead tissue—have to be removed, as in abundantly-suppurating wounds, ulcers, and gangrene. It is useful also in favoring the formation of new epidermis in pemphigus, and after extensive destruction of the skin by burns or caustic substances."

Domestication of the Wild-Turkey.—The following observations on the habits and domestication of the wild-turkey we take from a paper of similar title by J. D. Caton, published in the *American Naturalist*. Mr. Caton commenced domesticating the wild-turkey about ten years ago, his original stock having been procured from the eggs of the wild hen; it has been twice replenished in the same way. The young birds from the wild-turkey's eggs, when brought up in close intimacy with the human family, become very tame, but they are afraid of strangers, and when anything excites their suspicion they take wing and are off like a flock of quails. The young turkeys breed freely when a year old. Mr. Caton is now raising the eleventh generation of the domesticated wild-turkey, and says that the breed has not deteriorated either in size or in reproductive powers. But they have changed in form and in the length of the legs; the body is shorter and more robust, and its position is more horizontal. As regards color but little change was observed in the first or second generation; after that, the tips of the tail-feathers and tail-coverts began to lose the soft chestnut-brown of the wild-turkey, and to become lighter; the changeable purple tints of neck and breast assumed a greenish shade; the bristles on the naked portions about the head became more sparse or altogether disappeared; the blue about the head and the purple of the wattles became bright-red; the pinkish-red of the legs became dull or changed to brown. These changes of color were seen in the first year of the bird's growth, but in its second these marks of degeneration would in most individuals, especially the cocks, disappear, and the plumage would show the thorough-bred wild-turkey. Each succeeding generation shows these changes to be more pronounced, but each year as the bird grows older the shades of color of the wild parent become more distinct. But Mr. Caton has hens now three or four years old with brown legs and on whose feathers the white has very considerably superseded the cinnamon shade, and he is satisfied that without a fresh infusion of wild blood in the course of fifteen or twenty years more but few individuals would show the distinctive marks of the wild-turkey to any considerable extent.

The habits of the wild-turkey are not so rapidly changed as the form and coloring, still they too change. The wild-turkey cock by the time he is five months old seeks

a perch well up in the largest trees in his range, and as he grows older he is disposed to roost higher and higher, till he is frequently found at the very apex of the tallest tree. This habit is scarcely impaired by domestication in the second and third generations, but after that the birds grow less and less ambitious of high places, till at last they come down to about the level of the domestic turkey. The timidity characteristic of the wild-turkey is eradicated very slowly. When the wild-turkey in the forest voluntarily leaves her nest, she always covers it carefully with leaves. This is done with less care by the first descendants of the wild hen, and each succeeding generation becomes more careless in this respect.

Prof. Thurston on our Domestic Metals.—The statement is made by Prof. Robert H. Thurston that this country has for years been importing cast-iron, while domestic products of equal and even greater intrinsic value sell at lower price. Other similar instances of unwisdom are cited by Prof. Thurston, as, for example, the fact that we are importing boiler-plate at eleven cents a pound, when we can purchase American steel, vastly superior in all respects for the special purposes to which the former article is applied, at eight cents. Again, we import vast quantities of foreign steel tools, when at Pittsburg and elsewhere we make steel fully its equal. In New England and Pennsylvania we have ores from which is made the finest cast-iron ordnance in the world. In Ohio we make a metal for car-wheels such as is never seen in Europe, and of such tenacity and elasticity that foreign engineers listen incredulously when it is described. Our Lake Champlain ores make an iron fully equal to Swedish for conversion into steel; and around Lake Superior and in Missouri we have deposits from which comes Bessemer metal far superior to the phosphorus-charged metal we import. New Jersey supplies us with zinc which meets with no competition as a pure metal, and which can be used without purification even for chemical purposes; and our native copper is absolutely free from admixture with injurious elements. It is time that these facts should be known, and that the people should disabuse their minds of the idea that, because a commodity is "imported," it is therefore of greater intrinsic value than a domestic product.

The Deterioration of Silk Fabrics.—The complaint is frequently heard that the silk fabrics now manufactured are by no means as lasting as similar fabrics manufactured twenty or thirty years ago. That this complaint is justified, the *Warehouseman and Draper* admits, and then points out the causes of the deterioration. Adulteration of silk on a large scale, and systematically, began about eighteen years ago, soon after the silk-worm disease had made its appearance in the silk-producing countries of Europe, when raw silk rose from twenty-one and twenty-two shillings sterling per pound to as much as sixty shillings. In order to keep down the price of the manufactured goods, foreign materials were introduced, and these were often in excess of the silk. "It would be curious," says a writer on the subject of "weighting" silks, "to follow one pound of China or Italian silk through its various processes in reaching a silk dress. The silk is sent to the dyers, and the first process is boiling off. All silk in its natural state has a certain amount of gum in it; this must be boiled off, and, when this is done, sixteen ounces are reduced to twelve. It is then dyed black, and the process of weighting commences. The twelve ounces is sent to the manufacturer, varying from twenty-four to fifty-two ounces. I have to-day seen silk dyed and weighted in Lyons up to fifty-two ounces. Very large dye-works exist in Lyons for the purpose of doing this business; and it is done to perfection."

Fatality of Inebriety.—In an article on the "Duration, Mortality, and Prognosis of Inebriety," by Dr. T. D. Crothers, published in the *Quarterly Journal of Inebriety*, we are informed that the mortality of this disease has been estimated at from 96 to 98 per cent., or less than *four per cent of recoveries*. Under treatment in asylums the lowest estimate has been placed at 33 per cent., and from that up to 62 per cent. This excessive mortality is due, according to Dr. Crothers, to profound degenerations, produced by alcohol, and the peculiar conditions of low vitality, impaired and per-

verted cell-action, commonly preceding this disorder. The inebriate is literally in a toxic condition, in which all the organs are both unduly depressed and exalted, or in a state of suspended activity, bordering on paralysis. The mortality of the inebriate is further increased by the favoring conditions which bring on inflammatory affections, as pneumonia, pleurisy, gastritis, diseases of the kidneys, etc. Severe bodily injuries, too, have generally a fatal termination in inebriates. The existing degenerations seem to intensify the lesion and its effect, and reduce the resisting power of Nature to its minimum. The fatality of inebriety is increasing, and its complications are becoming more profound and general.

Uses of the Antennæ of Insects.—In working on the problem as to the use of the antennæ of insects, Mr. L. Trouvelot, as he states in the *American Naturalist*, procured a large number of butterflies of *Limenitis disippus*, and with about a dozen of these tested the truth of a statement to the effect that a butterfly deprived of its antennæ, on being thrown up into the air, falls heavily to the ground without spreading its wings. All these butterflies took flight, but there was a certain hesitation in their movements. The author next carefully covered with thick Indian-ink the eyes of several individuals; when this coating was dry they were allowed to go free. They could fly, and, though blind, avoided hurting themselves by dashing against any hard object. Both antennæ having been cut off from a blinded butterfly, the insect when thrown up fell heavily. Another butterfly, blinded and with antennæ removed, was set at liberty on a table. Then with a small brush a drop of sweetened water was held very near the mouth, head, spiracles, etc. The insect remained perfectly still; but, when the stumps of the antennæ happened to be touched, it unrolled its proboscis and searched for the sweet liquor. The next insect was treated like the last, save that a drop of thick gum-arabic was allowed to dry on the stumps of the antennæ. The insect could not use its wings, and was insensible to the touch of sugar-water on the sealed stumps. Experiments showed that insects deprived of their antennæ do not copulate. The author next cut off the antennæ of ants, and then let them go free with their comrades; these mutilated ants did not seem to recognize their fellows, nor did they follow the same path, but kept moving in a circle. The author, in summing up the results of his experiments, says that the sense located in the antennæ is not merely that of touch, hearing, or taste, nor a combination of all these: it appears to differ essentially from any of man's senses; it is a "kind of feeling or smelling at a great distance."

Moss-Copper.—The term "moss-copper" is used to designate accumulations of filamentous copper found in cavities, in pigs of certain kinds of regulus. This moss-copper appears to be formed at a comparatively low temperature, and it has actually been produced at a temperature far below redness, by W. M. Hutchings, who gives in the *Chemical News* an account of his interesting experiments. He fused a button of regulus, one-quarter of a pound in weight, under borax in a clay crucible, and then poured the molten mass into an iron mould. After it had cooled in the mould for some time, so that it had been quite solidified for some minutes, it was broken in two by a blow with a hammer. It had now cooled below redness, even in the centre. At the moment of fracture the surfaces exposed were perfectly clean and lustrous, but after a minute or two they became slowly covered with a growth of minute copper filaments, which increased till in some places it resembled a coarse velvet. After three or four minutes one of the halves was again broken in two, and again the exposed surface was lustrous. The piece was now just cool enough to hold in the hand, yet the moss-copper slowly began to appear here also, though not so abundantly as before, and only in patches.

Fauna and Flora of the Florida Keys.—L. F. de Pourtalès, in *The Naturalist*, signalizes the Florida Keys as a curious example, though on a very small scale, of a land of comparatively modern origin, which has received its fauna and flora from two different and very distinct sources—the West Indies and the North American Continent—

the flora being derived chiefly from the former, and the fauna mostly from the latter. The marine fauna of the coral region of South Florida he pronounces a West Indian colony engrafted on the more or less North American fauna of the east and west coasts of the peninsula. Of the land animals the mammals are entirely North American. The batrachia and reptiles, too, belong, with a very few exceptions, to North American species. The insects are probably of mixed origin, coming from North America, Cuba, and the Bahamas. The land-shells of the Keys are the same as those of the mainland.

As regards the flora of Florida and its Keys, the author says of the pine that it is confined to the mainland, there being only one small group of Keys which bears a growth of pines. Pine-forests, indeed, are characteristic of the shores of Florida, and of all the Southern States, while the characteristic trees of the Keys are fig-trees, quassia, torch-wood, mahogany, and a few others, interspersed with a dense shrubbery, in which several species of *Eugenia* are perhaps most common.

How the American Aborigines disposed of their Dead.—The modes of disposing of the bodies of the dead in use among the aborigines of America are classed by Mr. Edwin A. Barber, in the *Naturalist*, under four heads, viz.: inhumation, cremation, embalmment, and aërial sepulture. Of these, the first was most usually employed, the bodies being interred either in ordinary graves, in mounds, or in caves. Several tribes, among them the Lenni-Lenape, or Delawares, were accustomed to incase their dead in stone boxes or tombs. In tumulus-burial, the dead were generally laid near the original level of the surface, and the mound heaped over them. Only isolated instances of cave-burial have been signalized in the United States, as in Breckenridge County, Kentucky, and in the Cañons of Utah, Arizona, and New Mexico. Cremation was of two kinds—in graves and in urns. Among the Pueblos of Arizona and Utah the body was sometimes burned, and the ashes deposited in shallow tombs. Several tribes on the Gila River, in Southern Arizona, burned the bones of the dead in urns. But few cases of embalming are known to have occurred in the limits of the United States. As examples of this mode of preparing the corpse may be mentioned the Mammoth Cave and Salt Cave mummies of Kentucky. These bodies have been preserved by a rude species of embalmment and by exsiccation. Aërial sepulture was of two kinds—the first by suspension on scaffolds or in trees, the second by sepulture in canoes. Several tribes still employ the former mode of burial. The Sioux elevate the bodies of their dead into trees, or stretch them out on raised platforms, wrapping them in blankets and leaving them to the mercies of the elements and carnivorous birds.

Accurate Geological Estimates.—A good illustration of the exactness of modern geological science is found on comparing the results actually obtained in the sinking of artesian wells in London with the conclusions reached by Prof. Prestwich as long ago as 1851. In a work published in that year, "A Geological Inquiry respecting the Water-bearing Strata of the Country around London," Prestwich made the prediction that the chalk beneath London would be found to have a thickness of 650 feet, the upper green-sand of 40 feet, and the gault of 150 feet. At the time of this announcement, as we learn from *Nature*, no well in London had been sunk to a greater depth than 300 feet in the chalk, but now there are four deep borings which marvelously confirm Prof. Prestwich's reasonings. We take from our London contemporary the following table, showing the results as calculated by Prestwich, and as actually ascertained by borings:

STRATA.	Prestwich's Estimate.	Boring at Kentish-town.	Boring at Crossness.	Boring at Meux's Brewery.
Chalk.....	650	645	646	653
Upper green-sand.	40	18½	12	28
Gault	150	130½	148	159

"When it is remembered," adds *Nature*, "that the chalk graduates downward insensibly into the upper green-sand, and that it is almost impossible to decide on their line of separation, it will be admitted on all hands that the agreement between the estimated and proved results is marvelously close."

Mental Disease in Animals.—The pathology of mind in the lower animals, and more especially in domestic animals, is a subject which, singularly enough, has hitherto attracted very little attention, though it is one that ought to possess the highest interest to man. Dr. W. Lauder Lindsay, who for a few years past has devoted himself to the study of mental phenomena as exhibited in the animal creation inferior to man, contributes to the *Journal of Mental Science* the results of his observations upon the mental pathology of animals, from which it appears that in them insanity is virtually the same as in man. He notes, however, certain peculiarities in the case of the lower animals, the most important of which is the facility with which *artificial insanity* may be produced in them, either by ill-usage or by brain or blood poisoning; hence the whole course of insanity may be very conveniently studied in animals. This unworked field of comparative psychology presents to the ambitious young physician the opportunity not only of earning distinction, but also of adding to human knowledge, and thereby to human as well as animal happiness and well-being. "Let me," writes Dr. Lauder Lindsay, "commend the experimental and scientific study of the pathology of mind in the lower animals to those capable youths who at present fritter away their time, temper, and opportunities, on subjects both trite and trivial; who expend their ingenuity in improving upon Nature by drawing hard and fast lines of demarkation where she draws none; who discover in the last fashionable drug, or mode of drugging, a panacea for all the ills of the insane; who delight in barren statistics that have already been tabulated a thousand times, with results of no practical value."

Archæology.—The Lapham Archæological Society of Wisconsin is the name of an organization formed and located at Milwaukee, Wisconsin, for the purpose of instituting researches into the antiquities of that State. It proposes to survey and register the discovery of ancient mounds; collect and preserve the relics found; and to publish from time to time such information concerning the results of its labors as will lead to a better knowledge of the origin and character of the prehistoric peoples of the region of the Great Lakes and the Mississippi Valley. It has long been known that Wisconsin is particularly rich in remains of the mound-builders. In 1855 Dr. J. A. Lapham, after whom this society is fitly named, published, as one of the Smithsonian contributions, a quarto volume describing and figuring such as had then been observed. They have been discovered in great numbers since, and there is ample room for vigorous work in exploring and describing them before they disappear under the denuding operations of the plough and the harrow. They are so widely scattered and so small in size that their preservation is quite out of the question after the soil begins to be cultivated. It is to be hoped that the society will be able to push its labors successfully, and that its action may excite a spirit of emulation in other localities.

NOTES.

A DESTRUCTIVE tornado visited the vicinity of Elkhart, Indiana, on the afternoon of July 2d. It completely destroyed several buildings, and unroofed others, uprooted whole orchards, and distributed trees and rubbish over acres of crops. The progress of the storm was from west to east; but the buildings and trees all fell toward the south, as if they had been taken up by the northern portion of the whirling column, and thrown into the centre, which seemed south of the principal track of devastation. No one was killed outright, but one of the injured has since died. A correspondent suggests one fact connected with the work of this tornado, which he thinks seems to indicate the presence of a large amount of electricity, if, indeed, the manifestation was not chiefly electric. All the leaves on the trees, all the corn, grain, and other green things within the path of the hurricane, were seared and shriveled, as if by great heat.

IT has been found by Müller, of the Berlin Chemical Society, that steam at ordinary pressure, when sent into saline solutions, raises their temperature considerably above its own. A solution of common salt, so concentrated as to have its boiling-point 127°, may be raised to 125°, by sending into it steam at 100°. The more concentrated the solution the higher the rise.

THE power of resistance to the action of sea-water possessed by copper and phos-

phor-bronze respectively is shown by the result of an experiment made under the auspices of the Russian Government. The experiment lasted for six months, and at the end of that time it was found that the copper (which was of the best quality) had lost over three per cent. of its weight, while the loss of phosphor-bronze was but little over one per cent.

In a lecture-room experiment suggested by M. V. Meyer for showing increase of weight by combustion, a candle is attached to each pan of a balance, and above one a glass tube open at both ends is hung at nearly the height of the wick. In this tube is a piece of wire gauze holding fragments of caustic soda; after balancing the candles, one of them is lit, when the products of combustion are retained by the soda, and this end of the beam descends.

That toads will eat bees, would seem to be clearly proved by the observations of M. Brunet. As the bees of a hive were crowding in to escape from a rain-storm, some of them rested on the grass in the vicinity awaiting their turn to enter. M. Brunet saw a toad busy in devouring these bees. He carried the toad again and again to a distance of from thirty to fifty metres from the hive, but sooner or later the animal was at his post again, greedily devouring the bees.

While investigating the hygienic properties of pine and eucalyptus, Charles T. Kingzett found that by exposing a mechanical mixture of water and turpentine to a current of air at normal summer temperature, a solution containing hydrogen peroxide—a powerful disinfecting and oxidizing agent—and camphoric acid may be readily obtained. This solution contains no oil of turpentine, is non-poisonous, and without harm to textile fabrics.

It is noted as a curious fact by Sir Samuel Baker that a negro has never been known to tame an elephant or any wild animal. The elephants employed by the ancient Carthaginians and Romans were trained by Arabs or Carthaginians, never by negroes. A person might travel all over Africa, and never see a wild animal trained and petted. It had often struck Sir Samuel as very distressing that the little children never had a pet animal; and, though he had often offered rewards for young elephants, he had never succeeded in getting one alive.

At the meeting of the American Medical Association, at Chicago, on June 5th, the subject of the revision of the American Pharmacopœia, the proposed rejection of the one in use, and the substitution therefor of an entirely new, more modern and complete work on that subject, was postponed indefinitely.

The long-talked-of plan of heating a city by steam, generated at one or more points, and distributed by pipes, is at length about to be practically tried at Lockport, New York, where boilers and boiler-houses are now erected. The working of this new system will be watched with interest. The inventor estimates that the saving to each householder will be from thirty-three to fifty per cent. of the present expense for stoves, coal, etc.

Remains of an enormous dinosaur have been discovered in Colorado, and received at Yale College, which, according to Prof. Marsh, would indicate the length of the entire animal to have been about fifty or sixty feet! Portions of the sacrum and of the posterior limbs have been preserved; the last two vertebræ are nearly complete. From all the indications, Prof. Marsh concludes that it was an herbivorous reptile, and perfectly distinct from any species known. He names it *Titanosaurus montanus*.

From a study of no less than a hundred and six epidemics of typhoid fever, Jaccoud reaches the conclusion that the disease is engendered by fecal matter; but that this matter is not typhogenic, that is, does not of itself produce the typhoid symptoms, unless it incloses the specific poison of the disease. There are, however, he admits, circumstances under which such matter is poisonous, without having had any previous admixture of typhoid substances. In such cases the poison is, he says, elaborated in the fecal matter, which itself, as before, is merely an agent of transmission.

In 1861, 1,500,000 pounds of Indian tea was consumed in the British Isles; three years later the amount of this tea consumed was 2,500,000 pounds; in 1867, 6,000,000 pounds; in 1870, 13,500,000 pounds; in 1874, 21,000,000 pounds; in 1875, 17,500,000 pounds; and in 1876, 19,000,000 pounds. It is expected that the consumption for the present year will be not less than 32,000,000 pounds, or one-fourth of all the tea consumed in the United Kingdom. Indian tea has always commanded the highest price in the London market.

In testing the comparative explosiveness of nitro-glycerine, in the crystallized and the liquid state, Beckerhinn used a drop-block of wrought-iron weighing 2.130 kilogrammes, having at its lower end a hardened steel point of 7.068 square millimetres. The nitro-glycerine was spread in a thin layer on a flat anvil of Bessemer steel, and the weight was dropped from different heights. The liquor exploded at a fall of 0.78 metre, but the crystallized or frozen nitro-glycerine only at 2.13 metres.

WILLIAM STANLEY JEVONS.